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The Human Element In Power Plant Efficiency

THE controlling factor in the world's progress is neither money nor machines, but men.

It is an art to analyze the other fellow's logic, to set yourself in his position, and to perform the work to his satisfaction when you do not agree with him; but alas, this is a world of many people. While the technical part of an engineer's knowledge is important, it is of little value to a man without knowledge of human nature.

The handling of men and the ability to inject enthusiasm into their work is an art that few men have. It does not come in a short time. Only thinking men can put themselves in the place of their employees.

To teach men that you expect them to give not only the service of their bodies but also that of their minds, to make them see the advantages of doing so—that is the problem that confronts every directing man.

There is no machine entirely automatic. All depends more or less upon the human element. Therefore equal steps should be taken to evolve better power-plant men, as there are taken in making better machines.

If half as much interest were put into employees as is put into dead matter, most plants would operate better.

Common sense will often offset a great deal of so-called practical experience.

Proper treatment, reasonable pay, and opportunity for betterment and promotion are important factors. They develop high-class operating men, thoroughly efficient, who will have the interest of the company at heart.

Many an engineer, if he were left alone, would have a most up-to-date plant with top-notch efficiency, but with all that the company might become bankrupt. It is not only efficiency, it is the return on the investment that engineers should be concerned about. Be conversant not only with the technical, but also with the business side of the company.

Inefficiency often consists of many apparently insignificant things bulked together to make one large whole.

Operating engineers are often chock-full of improvements that will cost money, but are they getting maximum output with minimum input with the present equipment?

By Victor J. Azbe

Renewing Tubes, Headers and Baffles in Water-Tube Boilers*

Detailed directions, with numerous illustrations, telling how to take out tubes of water-tube boilers, how to put them in, how to go about removing and replacing cast-iron and wrought-iron tube headers and what must be done to put in new brick for the baffling in the tubes.

THE principal tool used in cutting out a tube or nipple is called a ripping chisel, shown in Fig. 1. The ripping chisel is made of a piece of $\frac{7}{8}$-in. octagon tool steel about 14 in. long, flattened for half its length to about $\frac{1}{4}$ in., the cutting end being concave, as shown, but of a thickness equal to $\frac{5}{16}$ in. for clearance. The ripping chisel is used for cutting and slotting the tube, all of which will be described later. Fig. 1 shows also an oyster knife which acts as a wedge for wedging the tube from the metal or seat into which it is expanded. A round-nose chisel about 14 in. long used for cutting purposes in the ordinary way is shown in Fig. 1.

Method of Removing and Replacing Tubes

Fig. 2 illustrates the method of loosening the tube from the seat into which it is expanded.

The first move in cutting out the tube is to cut two slots about $\frac{3}{4}$ in. apart on the bottom side of the tube, the cuts extending from the end of the tube to the tube seat, as illustrated at *A*, Fig. 2. When the cuts are made, the metal between the cuts should be lifted either by the use of a flat chisel, as shown at *B*, or by knocking

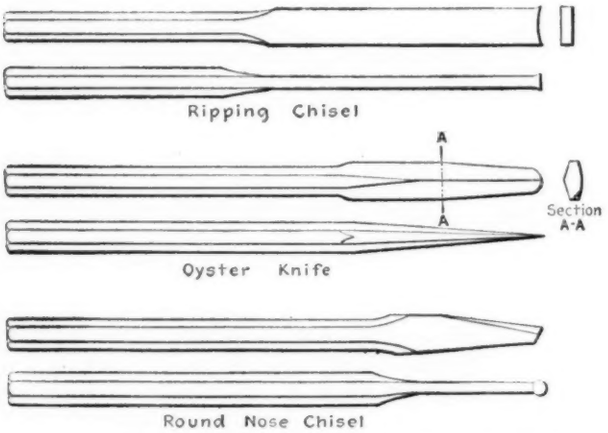


FIG. 1. CHISELS USED IN THE REMOVAL OF BOILER TUBES

up the metal from the bottom side. When this is done, it will be noticed that a portion of the seat directly under the lip of the tube is exposed; by the use of an oyster knife this portion of the tube can be lifted from the seat, as shown at *C*. The lip is then broken off and the ripping chisel is used as shown at *D*, cutting the slot from the inside portion of the seat to about from 4 in. to 6 in. from the seat, keeping the ripper at the same angle, as shown at *D*, *E* and *F*. In cutting the slots there will be a burr, but the top side of the ripping chisel will cut this burr clean and flush with the outside surface of the tube. The bottom of the tube is now slotted from about 4 in. to 5 in. from the end. The sides of the slotted portion of the tube can be turned in, as shown at *G*. This will decrease the diameter of the tube and allow that portion of it where it was originally expanded to be taken out through the tube hole. Care should be

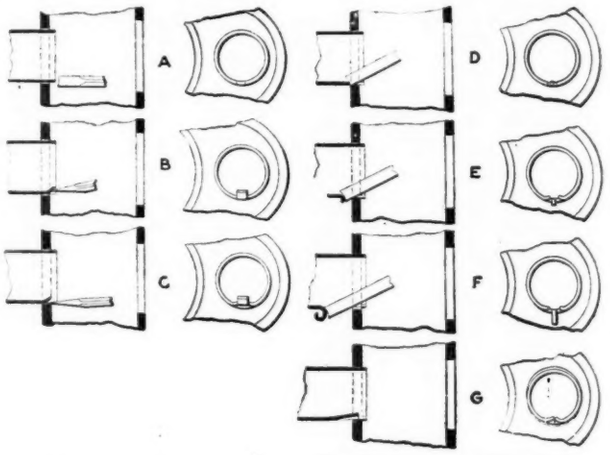


FIG. 2. PROGRESSIVE STEPS IN THE REMOVAL OF BOILER TUBES

exercised in the cutting out of a tube or nipple so as not to injure the seat; that is, not to cut a groove or slot across the seat. Both ends of the tubes should be cut in the same manner and the tube pulled out through the front header. Sometimes it is necessary to use a chain tackle to pull the tube out; at other times it will come out freely, depending upon the amount of deposit on the outside of the tube.

After the tube is out the seat should be thoroughly cleaned and examined, making sure that it is not cut. The new tube should be placed by putting it through the front header through the baffle plates into the rear header. The ends of the tube should project the same distance from the seats both in front and rear headers, and this projection should not be less than $\frac{1}{4}$ in. nor more than $\frac{1}{2}$ in. When the tube is set as outlined, it should be held at the rear end, so that when the mandrel is used in connection with the expanding of the front end the tube will not shift its position.

The Tube Expander

One of the principal tools used is the expander, illustrated in Fig. 3. The expander is made of steel and is made up of six parts: *A*, the collar; *B*, split guide ring; *C*, body; *D*, cap, and *E*, rollers.

The collar is a steel ring about $2\frac{3}{4}$ in. inside diameter, $\frac{5}{16}$ in. thick, $\frac{1}{2}$ in. wide. The split guide ring is of the same general shape as shown, with a number of parallel V-shaped grooves machined on the inside for the purpose of adjustment. The body is made up of one piece

*We are indebted to J. H. Davis, electrical engineer, Baltimore & Ohio R.R., for this article, which forms one of numerous bulletins issued by his office to men of the power plants of the Baltimore & Ohio Railroad system.—Editor.

of machined steel having a neck at one end, the outside surface of which has parallel V-shaped grooves (identical to those on the inside of the split guide ring). The neck is bored out smooth to 1½ in. in diameter, this hole extending through to the bottom of the body. The lower part of the body is about 2 in. thick and 3½ in. outside diameter. This part contains three chambers, the chambers being about 1½ in. high and so shaped as to contain rollers. The cap is simply a disk 3½ in. in diameter and ½ in. thick with a hole in the center 1½ in. in diameter, and is secured to the bottom of the expander by three screws. The rollers are pieces of tool steel 1½ in. in diameter by 1½ in. long, the edges rounded as shown, all of a hard temper. Three rollers are used, one in each chamber. There are two sets of rollers—one known as the straight roller, whose sides are parallel and both ends of the same diameter, and one known as the taper roller, which tapers from 1¼ in. diameter at one end to $1\frac{3}{16}$ in. diameter at the other end, and of the same length as the straight roller. The chambers in the expander body are so shaped and constructed as to allow the rollers to revolve freely, and at the same time not allow of their dropping out.

Mandrels are used in connection with the expander and are illustrated in Fig. 4. There are three kinds of

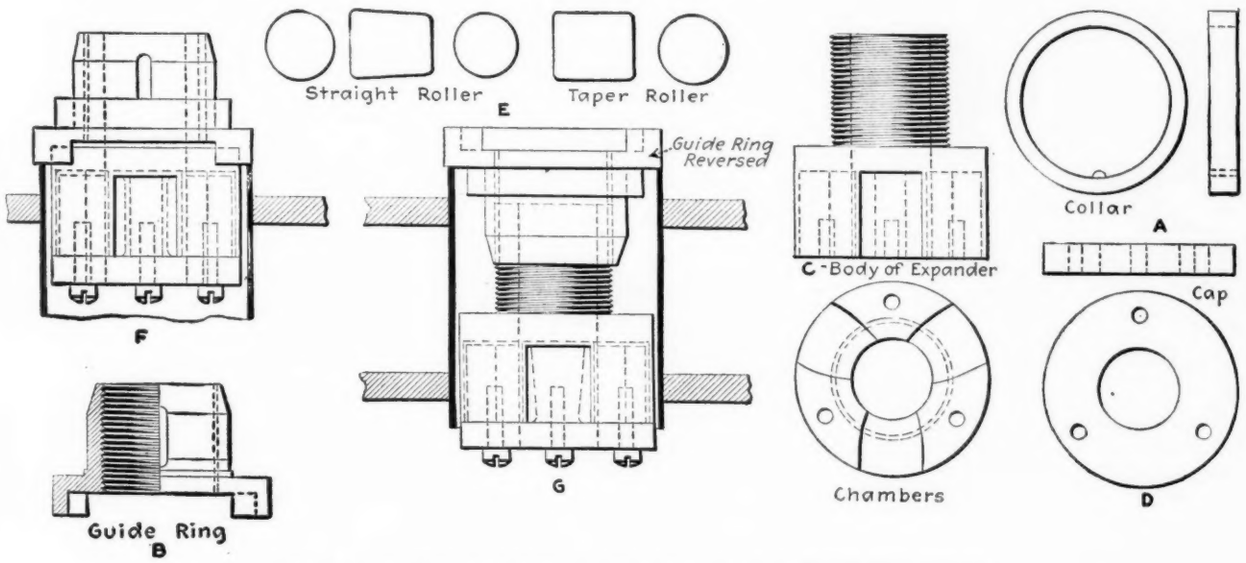


FIG. 3. SHOWING VARIOUS PARTS OF A BOILER-TUBE EXPANDER

mandrels, known as the straight mandrel *A*, the single-jointed mandrel *B*, and the double-jointed mandrel *C*. A mandrel is simply a tapered piece of steel, round in section and hardened. It is actuated by a turning pin *D*, the latter being simply a ⅝-in. cold-rolled steel rod usually 21 in. long, fitted into a hole at the head of the mandrel and acting as a lever to turn the mandrel. While the hardened taper part of the mandrel is the same in all three illustrations, the remaining portion differs in accordance with the requirements, which will be described later.

Expanding the Tube

The end of the tube projecting beyond the seat is called the lap, and in setting the expander for the tube this lap must be measured and the expander so adjusted that the top of the roller will project ¼ in. beyond the seat. For instance, if the lap of the tube is ½ in., then the bottom of the guide ring should be adjusted so that this ½ in. comes to a point ¼ in. below the top of the roller, as shown at *F*, Fig. 3. This adjustment is made by taking the collar from the guide ring and adjusting both halves of the guide ring, making them flush on the bottom and still come to the measurement as previously stated. The expander should then be placed in the front end of the tube and a straight mandrel inserted in the 1½-in. hole in the end of the expander. Two or three good blows are applied to the end of the mandrel, after which it is turned by the use of a turning pin, revolving always in the same direction. When the mandrel becomes slightly loose, a hammer should be applied to the end and the mandrel driven up, then the turning pin used again. Continue this process until the expander revolves evenly and there is an even tension on the turning pin. If you think that the tube is rolled, take the mandrel out by quickly turning it from right to left and applying a hammer on the side of the mandrel at the same time. Take the expander out and examine the expanded end of the tube. If the tube is fairly well rolled and impressions can be seen of the seat, it can be assumed that the tube has been rolled enough. However, this is entirely a matter of judgment. After the front end has been rolled then the rear end should be rolled in the same manner.

Expanding, as already stated, is a matter of judgment, common sense and experience. It is essential that the tube be not overrolled but be underrolled, if anything, and if upon testing the tube leaks then it may be rerolled slightly, but if overrolled the metal of the tube is hardened to such an extent that it will be difficult to make tight. The setting of the expander is identical with all tubes and nipples, and it varies only when expanding the bottom end of a nipple from the top with taper rollers, as will be considered later.

In Fig. 5, *A*, *B*, *C* and *D* show the manner in which the front nipples connecting the bottom of the front crossbox with the top of the front headers, the intermediate nipples as used in double-deck boilers connecting the bottom of the top headers and the top of the bottom

headers and the circulating tubes, are cut so that they can be removed and be replaced.

The front crossbox nipple connecting the top of the extreme side header is shown at *A*. This nipple is cut at the top, the work of cutting being done from inside the drum. The top of the nipple is cut identically as the end of a tube, the oyster knife and ripping chisel are used, the nipple crimped at the top decreasing its diameter. The other cut on this same nipple is made

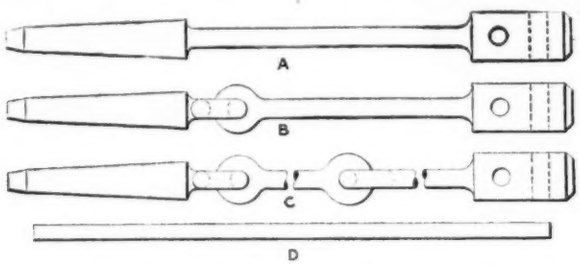


FIG. 4. THREE TYPES OF MANDRELS USED IN EXPANDING BOILER TUBES

just above the top of the header at *E*. The ripping chisel is used and the nipple is cut in half. The lower portion of the nipple where expanded into the header is driven down through the seat by striking the top of this part of the nipple with a blunt tool. The lower part of the nipple is then removed from the top handhole. The upper part is either drawn up through the crossbox or taken out through the bottom of the crossbox. In replacing this nipple, it is put through the hole in the crossbox from the interior of the drum, and sometimes it is necessary to slightly flatten one side of the nipple at its top to clear the corner of the crossbox.

The intermediate nipple connecting the double-deck section that connects the lower end of the top header with the top end of the lower header is shown at *B*. This nipple is first cut in half with a ripping chisel, the cut being made between the headers. A steel wedge can be used, driven in this cut, forcing both halves apart; the top half of the nipple is taken out through the lower handhole opening in the top header and the lower half taken out through the upper handhole opening in the bottom header. A new nipple can then be inserted from the handhole opening. If it is a rear nipple, it should be put in position from the bottom handhole opening in the top header. If it is a front nipple, it should be put in position from the top handhole opening of the bottom header. Before removing nipples that have been cut the burrs should be removed, so the nipple will pass through the tube seats. The mud-drum nipple, which is not shown, is removed similarly to an intermediate nipple. Where a man is skilled in this class of work, however, he will generally slot the nipple for its full length from the lower handhole opening in the rear header, close the nipple in to reduce its diameter, then remove it either from the mud drum or from the bottom handhole opening in the rear header.

The top end of the circulating tube *C*, expanded into the rear crossbox, is cut the same as the top of the nipple expanded in the front crossbox. The bottom of the circulating tube is cut in two at *F*, just above the top of the rear header. The lower part of the nipple is taken out through the top handhole opening of the rear header. The upper part of the circulating tube is removed from the rear crossbox by simply knocking it down until the top end is free from the crossbox, the bottom of the circulating tube just clearing the back face of the upper rear header. The tube is driven up from the bottom by use of a block and sledge until it clears the top of the rear header, when it is then brought down in place as shown at *D*.

EXPANDING A MUD-DRUM NIPPLE

In expanding a mud-drum nipple, the nipple must be so placed that the lap above the seat in the bottom of the header and the lap below the seat in the top of the mud drum will be the same; this lap should be divided up accordingly. When the nipple is adjusted, a bolt should be placed in the bottom of the mud drum, the head on the bottom of the mud drum and the nut so adjusted on the threaded end as to hold the nipple in place, as shown at *A*, Fig. 6.

Straight rollers are used in expanding the top end of this nipple to the seat in the bottom of the header, the expander adjusted so that the top of the roller will project $\frac{1}{4}$ in. above the top of the seat. The expander is placed in the nipple from the top end through the lower handhole opening; a single-jointed mandrel is used and

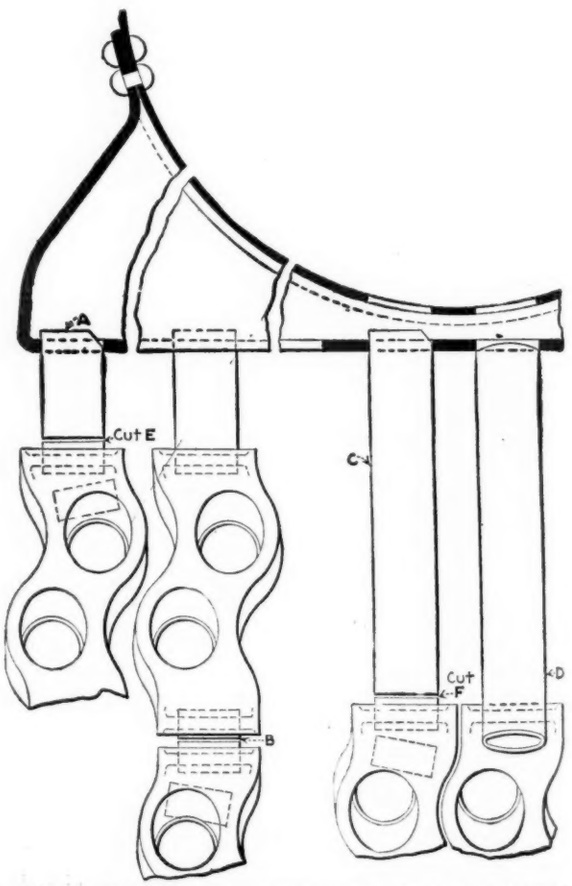


FIG. 5. SHOWING HOW TUBE NIPPLES CONNECTING HEADERS AND STEAM HEADER ARE CUT

is inserted through the second handhole plate from the bottom into the expander; a few sharp blows with a hammer on the end of the mandrel will be sufficient to spread the rollers stretching the nipple against the seat, after which the expander should be turned with a turning pin; the nipple should be watched so that the lap will be practically even all around the seat, and the expanding done in the regular way.

When the nipple is sufficiently expanded on the top, then the mandrel should be turned quickly from the right to left with the turning pin, after which the pin should be left in the end of the mandrel and a hammer brought to bear on the under side of the pin close to the mandrel head with an upward blow, so it will detach itself from the expander. To expand the lower part of the nipple into the seat at the top of the mud drum, taper rollers must be used, the big end of the taper toward the bottom of the mud drum, the guide ring reversed, as shown at *B*. Before the expander can be adjusted for rolling the lower end of this nipple, the nipple must be measured and the measurement of the lap from the lower end of the nipple to the bottom of the top seat of the mud drum should be measured and deducted from the length of the nipple. For instance, if the nipple is 4 in. long and extends through the bottom seat ½ in., the difference between the length of the nipple and this ½ in. at the bottom end will be 3½ in. The expander should be so adjusted that 3½ in. will measure from the shoulder of the guide ring as reversed to ¼ in. or ⅜ in. above the bottom end of the roller, as illustrated by *G*, Fig. 3. The single-jointed mandrel is used and is operated through the second handhole opening from the bottom of the header. When expanding the bottom end of a nipple from the top end of it, taper rollers should be used in every case, and by allowing the measurement taken from the shoulder of the guide ring as reversed to a point ¼ in. or ⅜ in. above the bottom of the roller, it allows the top of the roller to revolve clear of the bottom seat in the header. This is a matter that must be clearly observed and adhered to, otherwise if the top of the roller comes within ⅛ in. or ¼ in. below the upper seat it will tend to shear the metal of the nipple.

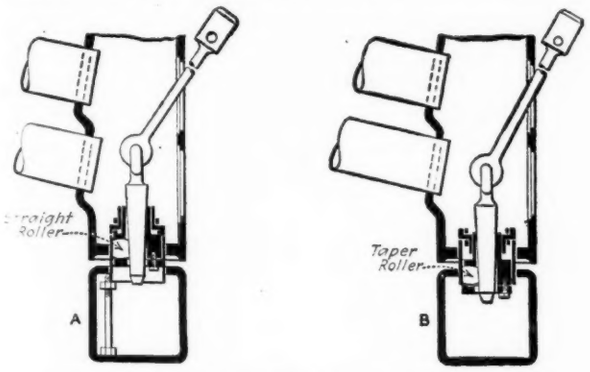


FIG. 6. EXPANDING THE MUD-DRUM NIPPLES

Expanding of Front and Rear Nipples in Crossbox at Top Front Headers

Before replacing nipples that have been cut out, it is necessary to make sure that the seat is clean of rust and oil and void of other imperfections. The lap of the tube must be evenly divided on the top and bottom so that it has the same projection through the top seat and bottom seat. Fig. 7 *A* shows the method of expanding the extreme end nipple in the crossbox, the expander being set identically as for expanding the end of a tube, the only difference being that a jointed mandrel is used for expanding the top of this nipple on account of its coming so close to the curve at the end of the crossbox. The manner of expanding the lower end of this nipple into the seat in the top of the header is shown at *B*. A jointed mandrel is also used in this operation, the expander being held in place, the mandrel inserted through the second handhole opening and driven up. A part of the mandrel will then bear on the bottom side of the handhole opening. Where this bearing occurs a piece of sheet copper should be used to prevent injuring the seat of the handhole opening. All the lower ends of these nipples are expanded in the same manner. The top ends, however, can be expanded with a straight mandrel, except the corner nipples, as explained.

Replacing the Cast-Iron Headers

In replacing cast-iron headers of the vertical and inclined type, it is first necessary to detach any connection at the top and at the bottom of the header. The header is then nicked on the sides of the handhole opening with a flat chisel, and by the use of wedges and wedge blocks the header is broken on a line running centrally from the center of the tube opening to the center of the handhole opening.

There are two sets of wedges used—one set in connection with the breaking of vertical cast-iron headers and one set in connection with the breaking of inclined cast-iron headers. The method of breaking both headers is identical; the wedges and wedge blocks are slightly different.

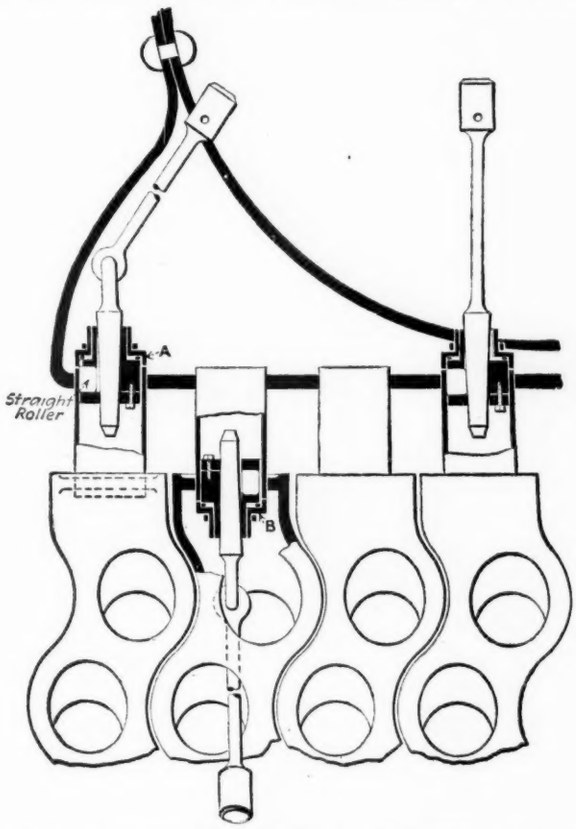


FIG. 7. EXPANDING NIPPLES IN CROSSBOXES AT TOP OF FRONT HEADERS

At the bottom of Fig. 8 is illustrated a wedge and two wedge blocks, the manner in which the wedge blocks are placed in the handhole opening and the location of the wedge between the blocks. The figure illustrates the wedge and wedge blocks for the breaking of inclined cast-iron headers and shows the manner in which the wedge blocks and wedge are placed. The

wedges and wedge blocks are shown in detail, so there can be no mistake in the manner in which they are placed.

Fig. 9 shows a bursting wedge and blocks in place, also the location of the crack running from the center of the top hole opening to the center of the top handhole opening. The broken portion is removed. The next handhole opening below is well nicked at the sides on a horizontal line with the center of the opening, the bursting wedges placed, and the wedge driven up with a maul until the break occurs, and in this same manner the header is broken each stage through each handhole opening to the bottom. When the portions of the broken header are removed, it will be seen that the ends of the tubes are flared where expanded into the header. The next step is to heat the ends of these tubes. This is done either with a small hand forge for the purpose, or by heating a cast-iron plug to a bright red (the plug being slightly smaller than the internal diameter of the tube and about 4 in. long); place this plug in the end of the tube and the heat radiation from it will heat the end of the tube to a cherry red; then a swage is used. A swage is made of a piece of steel one end of which is about 5 in. outside diameter and about 5 in. long; the other end is turned or forged down to a diameter of 2 in. and about 18 in. long. The big end of the swage is turned down inside on a taper to a diameter at the end of about $4\frac{3}{16}$ in., gradually tapering for 2 in. to a diameter of 4 in., and from that point the inside is turned straight to a diameter of 4 in. for about 1 in. When the end of the tube is hot, the swage is placed over the end and driven up until the end of the tube enters the inside surface of the swage, which has been turned to an even diameter of 4 in. when the swage is removed. It will then be seen that the outside diameter of the tube is 4 in., which is the size of its original diameter. This same operation of heating the ends of the tubes and swaging them should be done to each end of each tube. When all the tubes have been swaged down to the proper diameter, the header is put on by entering each tube through each tube hole in the header, after which the header is expanded in in the regular way. It should be noted that the swage is to be forced up just so far on the tube, otherwise when swaging, should the end of the tube be brought up solid it will loosen at the other end where expanded into the front header; if this happens the tube should be forced back by applying a block and a maul at the other end, re-expanding the other end before expanding the end of the tube into the new header. Swaging of the tube applies in all cases where headers are removed. All cast-iron headers are removed in the same general way; the only difference is in the design of the bursting wedge, which has already been explained.

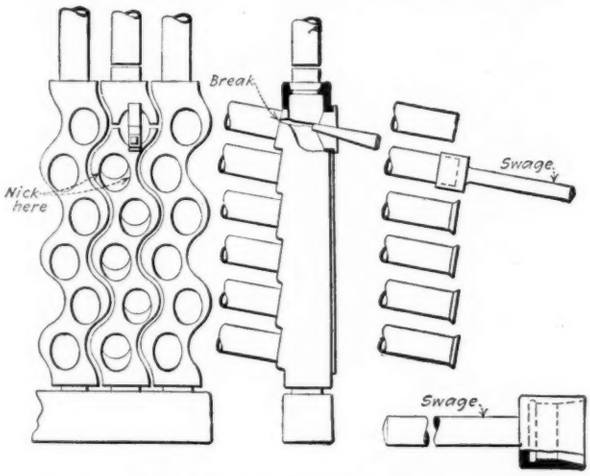


FIG. 9. APPLICATION OF BURSTING WEDGE AND BLOCKS IN REMOVAL OF CAST-IRON HEADERS

In the replacing of wrought-steel headers the tools used consist of a hand forge, or a plug which can be heated and inserted in the tube, identically as used by some in the heating of a tube before the swaging is done, a crimping bar and strong backs, all of which are illustrated in Fig. 10.

Before attempting to remove the header, any connections to the top of the headers should be cut and any connection to the bottom of the header should be cut, the header only held by the tubes. After this is done, the first operation is to heat the ends of the tubes to a dull red either with a forge or with a plug, and by the use of a crimping bar the ends of the tubes can be crimped so as to decrease the diameter at the end. The work of crimping should be done quickly and can be started first at the top end of a tube, second

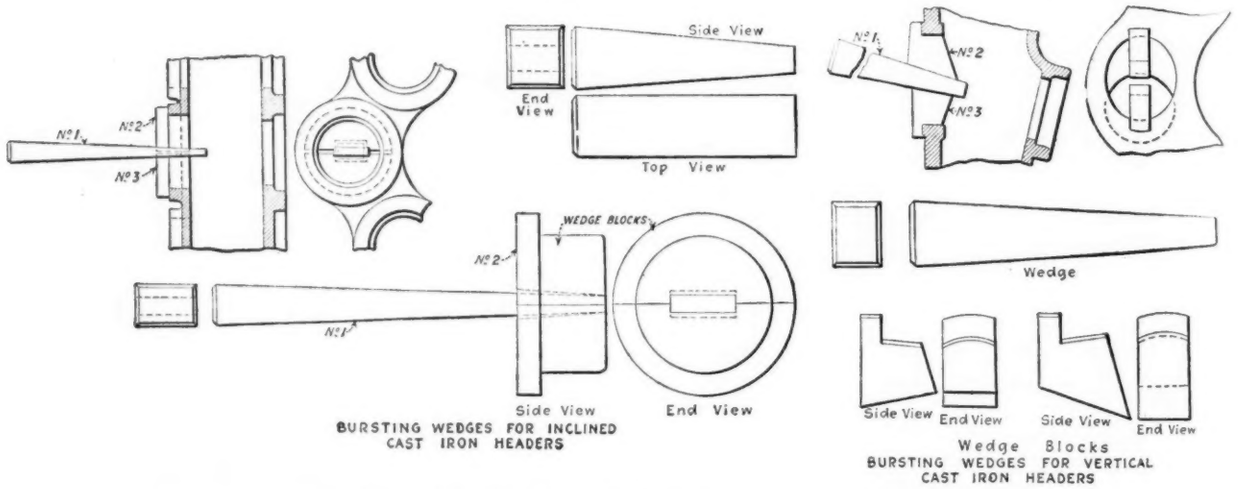


FIG. 8. SHOWING HOW WEDGES ARE USED IN THE REMOVAL OF CAST-IRON HEADERS

at the bottom, third at the right- and left-hand sides and then between points, closing in the ends of the tube so as to bring it to the original diameter of 4 in. This is done to each tube end, which is expanded into each seat in the header. When all crimping has been done, then strong backs are used as illustrated; that is, the plugs in connection with these strong backs are turned down at one end so as to fit the internal diameter of the tube and turned at one end to a diameter equal to the outside diameter of the tube. The clamp is placed inside of the header against the handhole, and the bolt comprising the strong back is turned, forcing the header from the tube. These strong backs should be placed in every alternate group of two tubes so that in pulling the header from the tubes it will be impossible for the header to turn one way or the other, but will pull straight from the tubes. When the header is removed, then the tubes should be swaged, as described previously in connection with swaging tubes in the removal of cast-iron headers. When the tubes are swaged to the proper diameter, the new header is put on by entering the ends of the tubes through the tube-hole openings in the header. There are times when the ends of the tubes are a little full; that is, the diameter is a little over 4 in. In those cases it will be necessary to jack the header in place by putting a jack at the handhole side of the header and forcing the header in position. The tubes are expanded in the regular way, the connecting tube or nipple made at the top and bottom of the header, the handhole plates attached and the job tested.

Replacing the Flame Bridges

In the Babcock & Wilcox type of boiler the groups of tubes are divided into three distinct parts by what is known as the flame bridges. The function of these flame bridges is to direct the passing of the gases from the furnace to the damper and flue. The flame bridges are made up of flame plates and tube brick. The flame plates are of cast iron about $\frac{3}{8}$ in. thick and are so designed as to close in the space between the tubes. The tube brick are designed to close in the space between the tubes, at the same time act as a protector for the flame plates, which, in turn, act as a backing for the tube brick.

In replacing a flame bridge the first thing necessary is to remove the tube brick, after which remove the flame plates. This is done by either breaking the brick in place with a piece of pipe, or prying the brick from the flame bridge and giving them a quarter turn so that they will drop down in the diagonal space between the tubes. When the tube brick are out, the bolts securing the flame plates top and bottom should be taken out, the flame plates given a quarter turn and taken out of the diagonal space between the tubes, either from the top of the boiler over the top tubes under the drum or from the furnace, or from the combustion chamber.

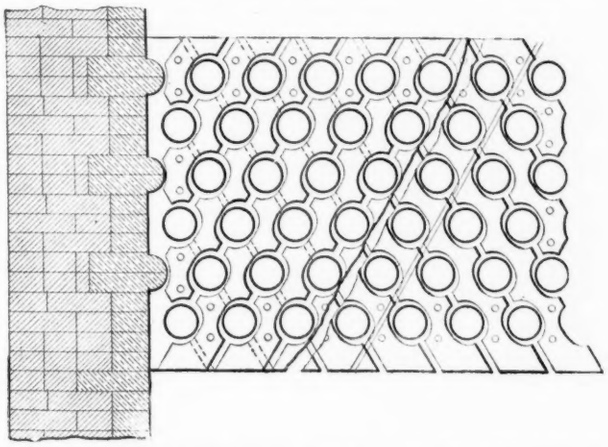


FIG. 11. SHOWS HOW THE FLAME PLATES ARE PUT IN

There are two sets of flame plates, one placed diagonally in one direction and one placed diagonally in the opposite direction, crossing each other and both secured at the top and bottom.

When the tube brick and the flame plates have been removed, the first step is to install the new flame plates. Fig. 11 shows the manner of doing this. The plates can either be installed from the top tubes or from the bottom tubes, or, if in a double-deck boiler, from the space between the upper and lower decks. It is necessary to install all the flame plates first that run in the

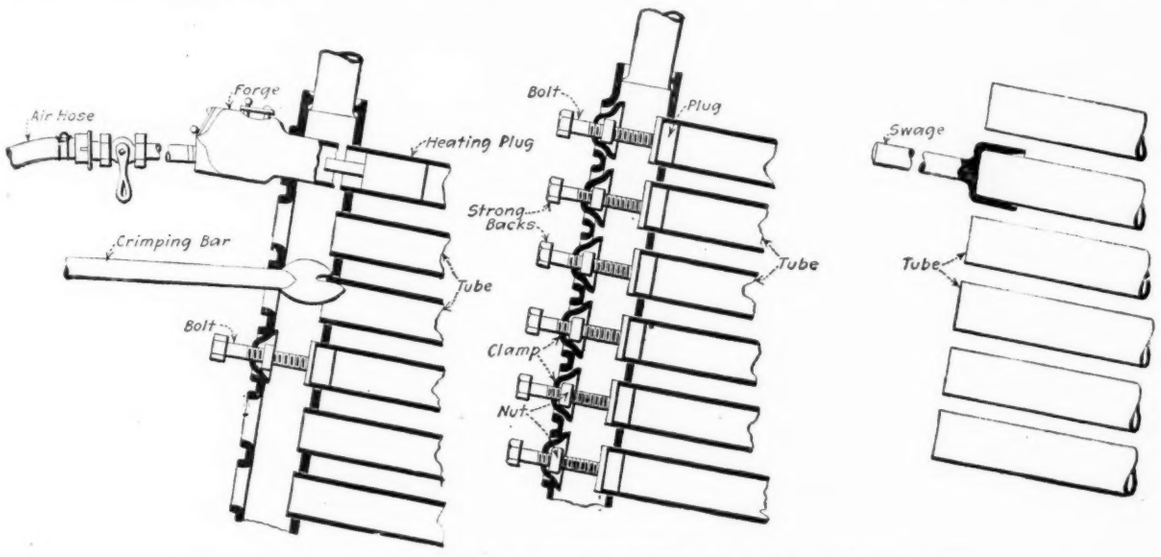


FIG. 10. SHOWING HOW THE WROUGHT-STEEL HEADERS ARE REPLACED

same diagonal direction by inserting the plate into the diagonal space and when its proper location is reached turning it so as to fill up the space, as shown. When all the plates in the same diagonal direction have been placed, then the plates in the opposite diagonal direction should be placed in the same manner, after which the plates should be secured with bolts at the top and bottom. At the top they will rest against a cast-iron L-beam which extends across the top tubes, the ends of which are secured in the wall. At the bottom they will rest against a cast-iron L-beam directly over the bridge-wall, the ends of which are secured in the side wall. If a double-deck boiler, the bottom ends of the plates in the top deck and the upper ends of the plates in the bottom deck will rest against a T-beam placed

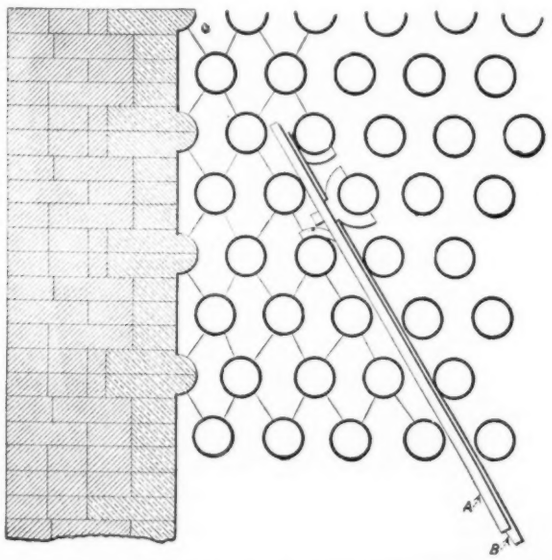


FIG. 12. USE OF TOOLS FOR SPREADING TUBES APART WHEN PUTTING IN THE TUBE BRICKS

between the decks in the same relative position as the cast-iron L-beams, the ends of the T-beam being fastened in the wall.

Not only are the L- and T-beams used for backing up flame plates but backing bars are used, some of them running in a diagonal direction and others running in the same general direction as the L-beams. The ends of the backing bars, both horizontal and diagonal, are secured in the side walls, while other portions are held by a backing collar secured to the tubes.

When the flame plates are in their right positions and secured, then the next step is to install the tube brick.

Installation of the Tube Brick

For the installation of tube brick there are three tools necessary—one is made up of a 1¼-in. square bar about 6 ft. or 8 ft. long; 10 in. from the end is a yoke so designed that a part of it passes through the hole in the bar and is secured to it with a nut. A second tool is made up of a 1¼-in. square bar with two pieces of 1-in. steel bent and secured to it, the centers of which are about 12 in. apart. The third tool is a specially designed pair of tongs used to handle tube brick. The tool marked *A*, Fig. 12, shows the tool with the yoke. This tool is placed diagonally between the tubes and is brought into position as shown, by twisting the end of the bar with a stillson wrench. This spreads the tube in a horizontal position. Tool *B*, as already described, is inserted directly behind tool *A* and can be either turned in position, as shown, with a stillson wrench or it can be brought from a position angular to the tube to a position right hand to the tube. These two tools are located about two feet from the flame plate and are used for springing the group of four tubes as shown. The next operation is placing the tube brick in the space bounded by the four tubes that have been sprung from their original position. In placing the tube brick tongs are used. The tongs are fastened to the tube brick, as shown, the tube brick is inserted between bar *B* and the flame plates, is entered in the diagonal space between the tubes either from the bottom or from the top of the boiler, whichever is the most convenient, and carried along, the flat sides of the brick parallel with the tubes. The brick is given a quarter turn, then turned and knocked with the tongs into place against the flame plates.

It is necessary to carry on this operation in the placing of each tube brick, and provided the tubes are fairly straight the brick can be readily placed.

Cleanliness and Order in the Plant

By J. J. Jahobart

All industrial and power plants, large and small, are making wonderful strides toward safety. "Safety First" is a paramount slogan in almost every plant today, and thousands of dollars have been spent to bring equipment up to the standard set by the American Museum of Safety. This money, in some cases lavishly spent, has produced conditions that the average employee thoroughly appreciates, but money alone will not maintain the safety standard of a plant and make it 100 per cent. foolproof.

To get the full results in practice it is vitally necessary that employees be thoroughly advised and trained in the value of cleanliness, as cleanliness is a vital part in safety development and it is a requisite that every crew should practice. There is little use in spending money for switch-gear, belt guards, etc., if tools are left lying about on the floor so that someone may fall over them. This one thing is the cause of too many minor accidents—"Mr. Careless" left something out of place. It is not the amount of labor involved in putting tools away as much as it is careless indifference and lack of personal pride. Have a place for each tool and see that it is kept there when not in use.

Watch your oilers; some of them are inclined to be careless regarding oil leaks, etc. It is likely that all oil-feed and return pipes were properly installed, but in time vibration is bound to cause leaky joints and a drop of oil here and there makes the unit look as though someone was "laying down on his job." It only takes a few minutes to tighten a joint or put a new gasket in a union, and if you can get an oiler to understand that you are looking to him to save the drops of oil, he will take a new pride in his work. Keep after the dirt because it is hard to convince the safety inspector that your plant is positively safe if he finds a pile of rubbish in every corner and tools, oily rags and waste thrown promiscuously about. He knows that someone about the plant is negligent in regard to cleanliness. Insist on real and permanent action regarding cleanliness—it pays.

Load Division Between Synchronous Frequency Changers Operating in Parallel—II

By QUENTIN GRAHAM
Engineer, Power Division, Westinghouse Electric and Manufacturing Company

Consideration is given to the conditions that must exist when two or more synchronous frequency-changer sets are to operate in parallel from both ends. Parallel operation of machines having similar characteristics and those having dissimilar characteristics is discussed.

THERE are certain conditions under which two synchronous frequency-changer sets operating in parallel on both ends will not take equal shares of the total load. In studying these conditions, it should be kept in mind that in any case, when two sets are in parallel, the total phase shift of each of the two sets is

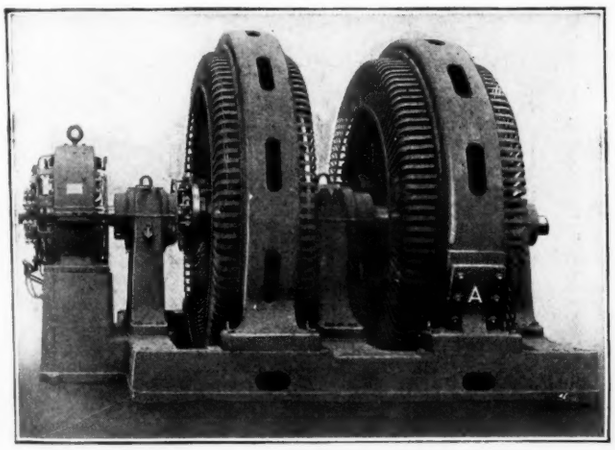


FIG. 1. SYNCHRONOUS FREQUENCY-CHANGER SET AND DIRECT-CONNECTED EXCITER

the same. If the sets are not identical in design or are of different size and rating, the amount of load required to cause a certain shift in one of them may not cause the same shift in the other. In such a case the loads must automatically adjust themselves so as to make the phase shifts equal. Even with identical units a change in the field excitation of either of the motors or generators will result in a change in the load division.

It has been pointed out (in the previous article, Oct. 8 issue) that when the excitation of a motor is changed so that it operates at a different power factor, its amount of rotor shift for a given mechanical load is changed; and when the generator excitation is varied, the amount of phase shift of its voltage for a given energy load is changed. Starting with equal loads on each of the sets, then, the amount of energy transferred by each may be varied at will over a fairly wide range by changing the excitation of the different machines, for the loads must adjust themselves so that the two sets have equal total shifts at all times.

In other words, overexcitation of the motor of one set causes that set to take more energy load; or conversely, a reduction of its excitation causes it to be relieved of a part of the total load. In any other application of a synchronous motor, whether it drives some mechanical device or is part of an alternating-current or a direct-current set, or even part of a frequency-changer set that operates alone, a change of the field excitation simply causes the power factor to change, while the energy load is not affected since the latter depends entirely upon the apparatus that the motor drives. With two parallel frequency-changer sets the power factor of either motor cannot be varied at will without causing corresponding changes in the energy load of both sets. If the operator desires to run the motors overexcited to help out the power factor of the system, he should increase the excitation of both of them by the same amount so as to keep the loads of the two sets equal.

The effects of overexcitation and underexcitation of the generator end of the set are the same as for the motor end—the overexcited machine takes the larger share of the load. Here, again, the problem is different from most other applications. When two generators

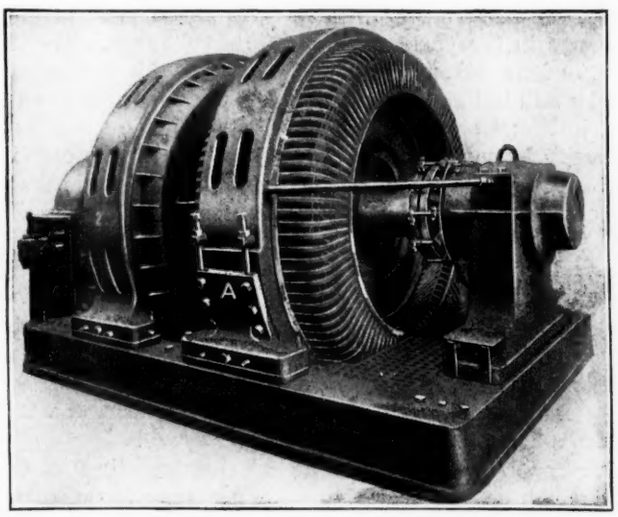


FIG. 2. SYNCHRONOUS FREQUENCY-CHANGER SET, ONE MACHINE MOUNTED IN A CRADLE

operating in parallel are driven by separate engines or other prime movers, or by either direct-current or induction motors, the division of energy load between them cannot be controlled by varying their field excitation. Variation in field excitation in those cases changes the power factor of the generators; the machine with the higher excitation takes more of the reactive or wattless kilovolt-amperes. But with two synchronous frequency-changer sets connected in parallel, unequal excitation of the generators results in an unbalance of the energy load as well.

An attempt by the operator to shift more of the wattless kilovolt-amperes to one of the generators would cause that generator to take additional energy load as well. Should it be desired to keep the energy loads of

the sets practically the same but to unbalance the wattless kilovolt-amperes of the generators or of the motors, this may be accomplished by manipulating the field rheostats of all four machines. The combined phase shift of an over-excited motor and an underexcited generator can be made the same as that of an underexcited motor and an overexcited generator, so that the energy loads would divide equally although the wattless kilovolt-amperes would not. In this connection it should be remembered that a certain amount of shift in the machine having the smaller number of poles has a greater effect on the total shift than a similar change in the machine having the larger number of poles.

The discussion so far has been applied to the case of two sets so arranged that at no load their generator voltages are exactly in phase. It was assumed that the poles of the similar machines were in perfect alignment, and although not stated specifically, it was implied that the stators were likewise aligned so that the corresponding slots or coil groups were in a direct line parallel to the shafts. It is quite easy to imagine a case in which this is not true.

For example, there might be two sets which are so aligned that their generator voltages are in phase at no load, but which are equipped with adjustable couplings between the shafts of the motors and the generators. Then, if the coupling of one set is loosened and the generator rotor is moved a few degrees ahead and the coupling bolted up again, there will be a corresponding change in the phase position of its voltage relative to that of the other generator. That is, with the motor poles still in line the generator poles will be slightly out of line, and since maximum voltage occurs in a given group of conductors at the instant at which the center of a pole passes the center of the group, it follows that the two generators will have voltages which do not reach their maximums at the same instant. This change could have been brought about just as well by shifting the whole stator of the generator in the opposite direction to which the rotor was moved. In fact, many synchronous frequency changers are arranged so that one of the stators may be shifted circumferentially through a few degrees by means of a cradle frame and shifting screws. Such a device is shown at *A* in Figs. 1 and 2.

By applying the reasoning of the preceding paragraphs, it will be evident that such change in the relative position of the rotors or of the stators will have a decided effect upon load division. The rule which has been formulated, that the total shift of each set must be the same, must still hold. But in this case one of the sets is handicapped by its having been shifted ahead mechanically through a few degrees; so that when the two are in parallel and carrying load, that set will have to take a large enough share of the total energy to overcome its handicap and bring its generator voltage back into phase with that of the other generator. Had the mechanical shift of the rotor or stator been in the opposite direction, the result would have been a decrease in the load of that set and a corresponding increase in the load of the other set.

It is interesting to consider what would occur if there were no external load on the generators, but yet they were in parallel and one of the movable stators was shifted through a small angle. In this case the machine that was moved ahead would give out, at its generator end, energy which would be absorbed by the other generator running as a motor. The first set would have a positive load and the second set a negative load. The motor end of the second set in this case would act as a generator and return energy to the line. Thus the result of mechanical displacement of one of the stators is a circulation of energy through the four machines, with consequent losses and heating in the windings, even though there is no external load. It is quite important, therefore, to have machines adjusted so that at no load there is no circulating energy, and it is for this reason mainly that at least one of the sets should have one of its machines mounted in a cradle frame when parallel operation is contemplated.

Even though the sets are duplicate, there may be slight differences in the machining of the feet or the drilling of coupling-bolt holes or in the foundations on which the machines are set, which would be sufficient to cause a noticeable phase difference between the generator voltages when the motors were operated from the same line. Such a difference could be corrected easily by shifting the movable stator in the right direction. Of course the same result could be obtained by having an adjustable coupling between two of the rotors, but the other arrangement is more feasible from the standpoint of mechanical design and more convenient from the standpoint of operation. The movable stator may be adjusted while the machine is in operation, but any adjustment of the rotor coupling would necessitate a shutdown.

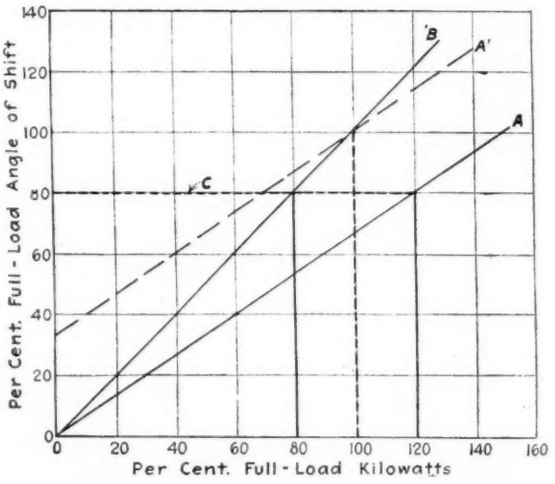


FIG. 3. HOW LOAD DIVIDES BETWEEN MACHINES HAVING DIFFERENT ANGLES OF PHASE SHIFT

In making the final adjustment between two sets that have just been installed, an ammeter may be connected in the circuit between the generators and the machines operated with no external load. Then the movable stator may be shifted in whichever direction is necessary, so as to cause the ammeter to read zero. With this setting there will be no circulation of energy at no load and equal division of energy at all loads, assuming, of course, similar units and equal excitation, and there should not, ordinarily, be any occasion to change the setting.

When two sets of dissimilar design are operated in parallel, it is sometimes found that although they are

adjusted for correct operation at no load, they do not share the load properly at full load. In other words, the amount of shift of one set for a given output is inherently greater than that of the other set. This may be illustrated by means of the diagram, Fig. 3. The lines *A* and *B* represent the relation between total angle of shift and kilowatt output of two sets that operate in parallel. Vertical lines dropped down from the points at which these lines are cut by the horizontal lines indicate the proportion of the load which each set carries, since the shifts of both sets must be the same. For example, at 80 per cent. full-load shift, as indicated by the dotted line *C*, machine *B* will take only 80 per cent. full-load kilowatts while machine *A* will take 120 per cent. full-load kilowatts.

In order to have equal division of load at all points, the lines *A* and *B* must necessarily coincide, but when they do not, as in Fig. 3, if these lines can be made to intersect at some point, say at full load, there will be equal division of load at this point only. This can be brought about by setting one of the stators, say machine *A*, slightly ahead, which has the effect of shifting the line *A* to the position shown by the dotted line *A*. In this position there is equal load division at 100 per cent. full load, but at no load there is a circulation of energy between the sets. It is possible, then, to adjust the two sets so that at some one point they will have equal load divisions, but at all other points the loads will be unbalanced. The problem is somewhat similar to that encountered in paralleling direct-current generators that have dissimilar regulation curves. To secure satisfactory parallel operation of either type of apparatus, the machines must have similar characteristics.

Injury by Military Guard

One Sweetman was employed at the power plant of the Laredo Electric and Railway Co. In going to work one night, he crawled through a hole in the wall surrounding the place and was shot by a soldier constituting a member of United States troops stationed around the plant to ward off a possible Mexican raid. Sweetman sued the company for damages, claiming that the soldiers must be regarded as employees of the company in such sense as to make it liable for any negligence on the part of the particular guardsman.

In a recent decision the Texas Court of Civil Appeals finds that plaintiff was properly nonsuited on the ground that, the soldiers having been stationed at the place in the public interest and at the order of a commanding general of the United States Army, and the guard being free from any control by the company, they could not be regarded as representatives of the company. (204 Southwestern Reporter, 701.)

Plaintiff then fell back on a claim that liability should be fixed on the ground that the company had failed to take proper precautions to guard its employees against dangers incident to the presence of the soldiers. The court holds that liability might be predicated on this ground if the facts supported the claim, but it is found that defendant company had taken all reasonable precautions by providing a safe entrance through a gateway and by posting notices warning employees of the presence of soldiers near-by.

New Essington Plant

MANUFACTURING facilities at East Pittsburgh, the location of the Westinghouse companies, have about reached their limit on account of the lack of available land, and because over 25,000 people are employed in these works. It therefore became necessary to select a new site which would be capable of expansion to a size comparable with East Pittsburgh, and Essington, or South Philadelphia was selected. This property, which embraces 500 acres, with a frontage of 4500 ft. along the Delaware River, lies nine miles south of Philadelphia.

The power and lighting systems possess a number of features of unusual interest. Desiring to make use

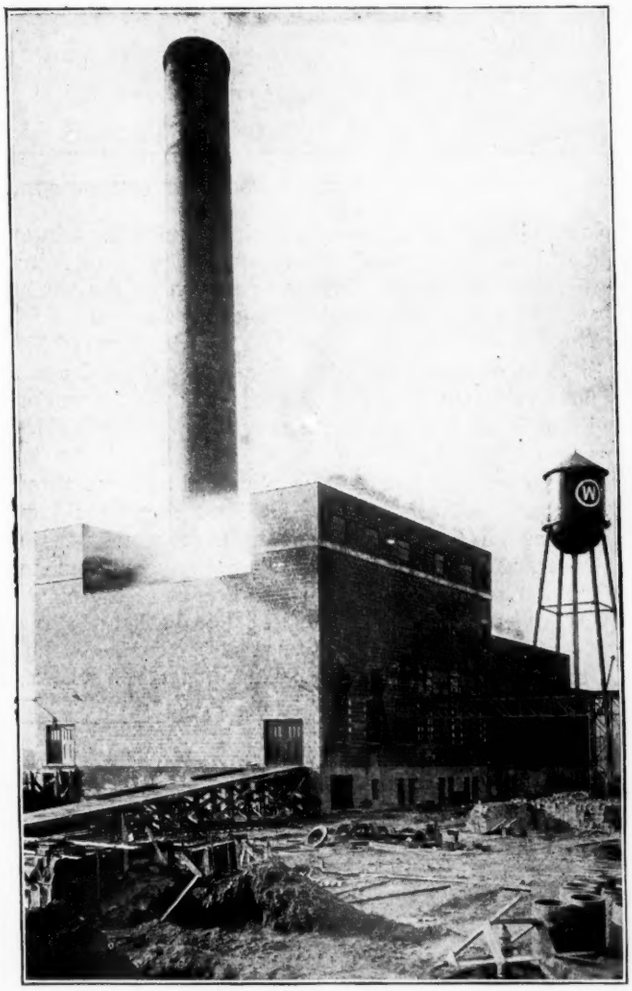


FIG. 1. NEW PLANT AT ESSINGTON

of central-station power, and at the same time secure steam for heating the buildings economically, the management has effected with the Philadelphia Electric Co. an arrangement that promises to work out unusually well for both companies.

Steam heat is required in the winter months but this demand falls off, naturally, in the summer, when no steam is required except for testing purposes.

On the other hand, during the winter months, the Philadelphia Electric Co. has a heavy load, which is materially lessened during the summer months. An agreement was effected whereby the Westinghouse Co.

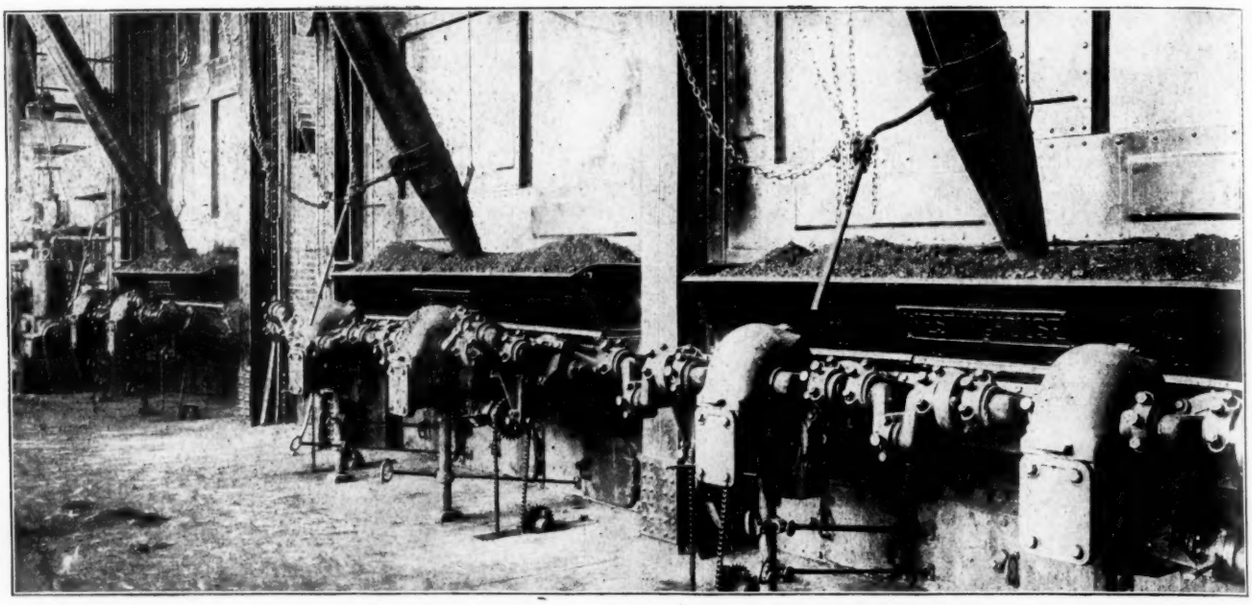


FIG. 2. BOILERS AND STOKERS IN THE NEW ESSINGTON PLANT

operates its own plant, noncondensing, during the winter and utilizes the exhaust steam, and when there is no need for heat, current for the operation of the works is secured from the Philadelphia Electric Company.

Three-phase 60-cycle current is delivered at 66,000 volts to an outdoor substation, where it is stepped down to 6600 volts, the distribution pressure over the works, and sent to the power house through lead-covered cables carried underground.

The power house, Fig. 1, contains at present three three-phase 6600-volt 60-cycle 1500-kv.-a. steam turbines which, as already stated, operate noncondensing. A switchboard of two panels, with the necessary measuring and switching devices, controls the output of the plant. Space is provided for the additional installation of three 3000-kv.-a. units. Steam is supplied from six 625-hp. Stirling boilers using Westinghouse underfeed stokers. These are shown in Fig. 2. Excitation for the generators is supplied from both motor- and steam-driven exciters, while direct current for the operation of the switchboard and the high-tension switch in the outdoor substation, Fig. 3, is furnished by a storage battery of 60 cells with a capacity of 80 ampere hours.

Distribution to the various buildings is accomplished by means of substations, four of which have been installed. The 6600-volt current is here stepped down to 440 volts for all constant-speed motor applications such as elevators, air compressors and machine tools. For operating blowers, furnaces, cranes, and other variable speed applications, direct-current 250-volts is obtained from rotary converters in the substations.

To improve the power factor, the rotary converters are operated at 100 per cent. power factor, and the synchronous motors used for driving the air compressors

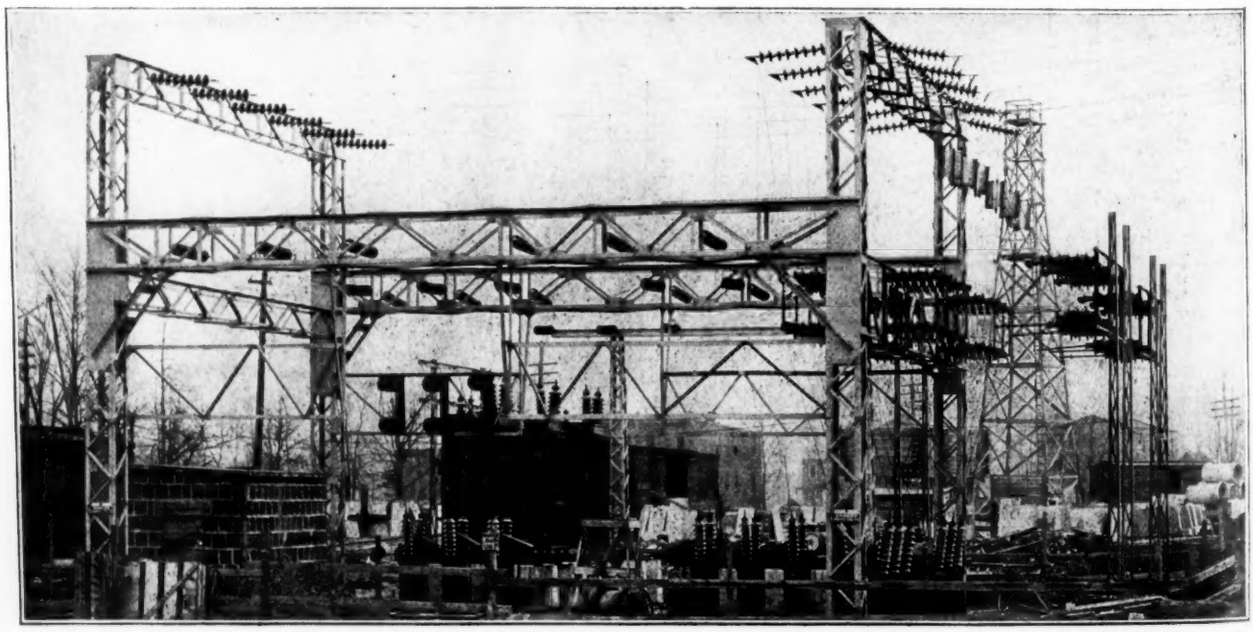


FIG. 3. THE OUTDOOR ELECTRICAL SUBSTATION AT ESSINGTON

in the substations, are slightly over size, the excess in capacity being used also as a corrective measure. Fig. 4 shows one of the synchronous motor-driven air compressors. From the substations, current is carried to the various buildings through underground cables to switchboards, from which it is distributed to the motors.

The lighting system is separate from the power, being supplied through separate transformers installed in cash substation, by which the potential is reduced to 440 volts, the distribution pressure throughout the buildings. To reduce this potential to that of the lamps, 110 volts, transformers are installed outside of the buildings.

To obtain an ample supply of water for manufacturing purposes, a seven-foot canal from the Delaware River was dug, with a surface at high tide of 45 ft. A settling basin of concrete serves to remove the mud and silt. The canal ends in a concrete receptacle on the testing floor of the erecting shop where a large amount of

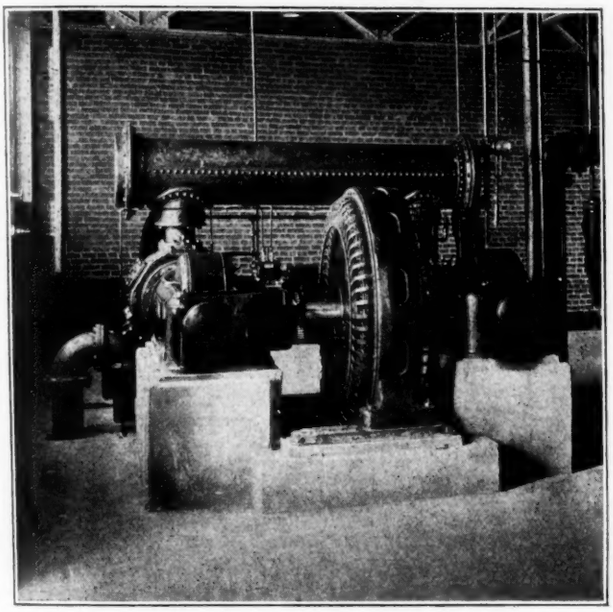


FIG. 4. SYNCHRONOUS MOTOR-DRIVEN AIR COMPRESSOR

water is required for the testing operations. This box also serves as the distributing center for the other buildings.

Waste water is emptied into a similar receptacle located above the one mentioned, from which it is discharged to a 78-in. concrete pipe that connects with the discharge canal which also acts as a storm sewer for the plant. Fire protection is obtained from the reinforced intake flume and pumped to a tank from which it flows by gravity. For taking care of the sewage, an elaborate plant has been installed employing the Imhoff system with lime as a precipitant, sludge basins being used to dry the effluent from the tanks. Water for drinking and cooking purposes is obtained from the city of Philadelphia Water Works. All machines in the shops are motor-driven.

The Wright Brothers of Dayton, Ohio, were the first to master the science of aircraft. Many others had tried to give wings to man, but Orville and Wilbur Wright were the first to succeed in a practical way, and are now universally recognized as the parents of flying.

Modulus of Elasticity

When first met with, the term modulus of elasticity or in fact any such term seems formidable, but if analyzed its meaning becomes clear and really interesting. Modulus, for instance, means primarily a measure and is usually applied to a small measure or a miniature such as a fractional part or a proportion, a small model of something. As a general thing it is a compound or composite measure. A certain lot of measurements, values, quantities or effects when "boiled down" is a modulus. For example, the modulus of a machine—the ratio of the load to the power—is simply the efficiency of the machine, but it involves a combination of several measurements or effects the resultant of which is finally expressed in one term. The term is met with in a great variety of combinations. That of modulus of propulsion is a good example. "If 100 cubic inches of cylinder capacity are needed to move a 20-ton locomotive one inch, we divide 100 by 20 and get the cylinder capacity that is needed for each ton. This quantity we have named the modulus of propulsion."

Perhaps the modulus most frequently met with by the engineer is that of elasticity, known also as Young's modulus. It is defined as "a numerical quantity denoting the resistance of a substance to longitudinal stress"—the stretching force required to double the length of a wire, for instance, of a given material and unit cross-section. The unit of cross-section is one square inch and the stress is in pounds or tons as most convenient, considering the material that is being tested.

For lead and the like, pounds is the unit of stress, while for steel tons is a better unit. It is not necessary or even possible in most cases to actually stretch the material to twice its original length because it would break before doing so; besides, the cross-sectional area would diminish greatly before it had elongated to any such extent and the stress required would be proportionately reduced. The test is confined well within the elastic limit of the material.

In practice the elongation is not carried beyond a small percentage of its original length, and for the purpose of test the cross-sectional area of the specimen need not be one square inch so long as its area is known. The modulus, then, is the product of the original length and the stress (stretching force) divided by the product of the cross-sectional area and the strain (elongation or deformation). It should be borne in mind that the same terms apply to the elasticity of compression (to one-half its original length) as well as extension. It is, however, called the compression modulus. Properly speaking, the modulus of elasticity is the stress (pounds or tons) required to produce unit strain (deformation, such as elongation or compression), but it is sometimes erroneously used in the reversed order; namely, the strain (deformation) produced by a given stress (weight or pull). In other words, it is pounds (stress) per unit distance (strain), which is always double or half the original length and not a measured change of length (strain) produced by the application of unit stress. It is a measure of the stress required to produce unit strain, and not the strain produced by a given stress.

FIG. 1. LARGE REFRIGERATED BEEF HOUSE, INTERMEDIATE DEPOT FOR AMERICAN ARMY IN FRANCE

Refrigerating Plant, Intermediate Depot for American Army in France

By ROBERT K. TOMLIN, Jr.
Staff Correspondent on American Front

Refrigerating plant for American Expeditionary Force to care for storage of 5000 tons of meat. Direct expansion is used, and provision is made for raw and distilled water ice-making. The cost of the plant was $2,000,000; army men built and operated the plant ahead of schedule despite most serious transportation difficulties.

ONE of the features of the intermediate depot is the big refrigerating and ice-making plant, which has been in operation since May 2. It serves as a cold-storage house, Fig. 1, for meat and other perishable products required by the army, and was designed originally to have a capacity of 5000 tons of frozen meat at a temperature of 12 deg. F., in addition to the production of 500 tons of ice daily. The first plans have been altered to some extent as regards the temperature in the cold-storage rooms. To obviate the necessity of icing the railway cars in which the meat is transported from the refrigerating plant to the front, a lower temperature than that originally contemplated is being maintained in the storage room. During my visit to the plant the thermometer indicated one degree below zero. By maintaining this temperature, which is the present operating practice, meat can be delivered to points of consumption without the use of iced cars.

The refrigerating plant consists of a group of twelve principal buildings, some of which are of the following size: Meat storage, 112 x 896 ft.; ice-making, 100 x 218 ft.; ice storage, 68 x 218 ft.; engine room, 60 x 170 ft.; boiler room, 53 x 170 ft.; pump room, 25 x 38 ft.; machine shop and store room, 64 x 96 ft.; laundry, 24 x 50 ft. In addition there are a few miscellaneous buildings and a concrete reservoir 55 x 65 ft. in plan. For its operation the refrigerating plant requires 4,000,000 gal. of water daily, which is obtained from a river two-thirds of a mile distant, by means of a 16-in. pipe line and a pumping station. The engine, boiler and pump-room equipment includes eight 250-hp. horizontal-tubular boilers, four refrigerating machines having a total capacity of 1100 tons refrigeration, equivalent to the cooling effect obtained from the melting of 1100 tons of ice daily. Fig. 2 shows the machinery during the installation period. There are two 150-kv.-a. electric

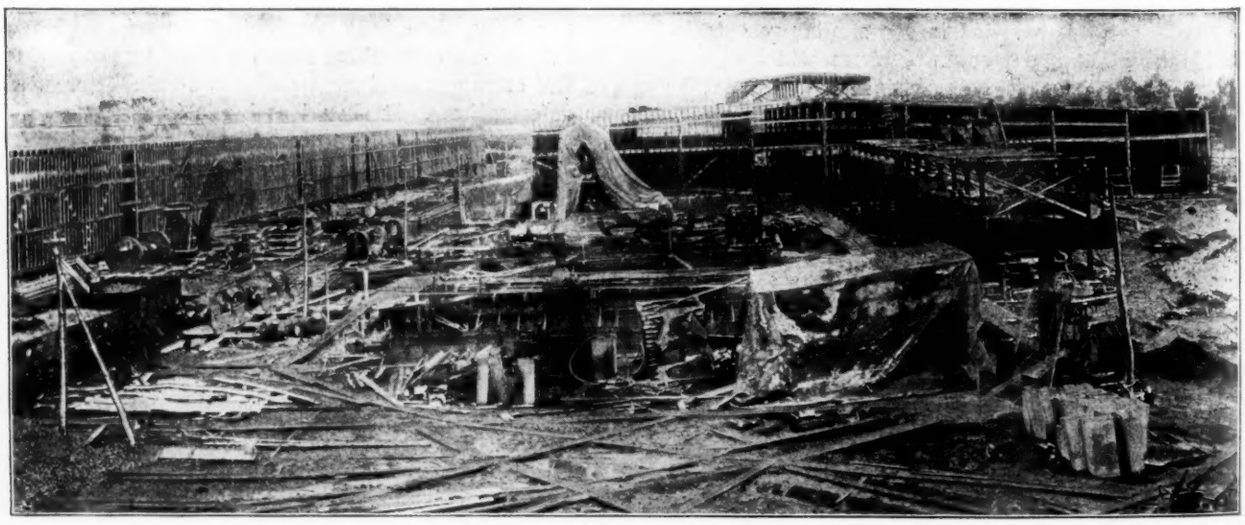


FIG. 2. THE REFRIGERATING MACHINERY DURING INSTALLATION, INTERMEDIATE DEPOT

generators, and three turbine-driven centrifugal pumps, each with a capacity of 1800 gal. per min., or a total capacity of 5400 gal. per min. Reciprocating boiler-feed pumps interconnected are used. A 4-in. feed-water main in duplicate is run from the vertical closed feed-water heaters to the boilers. Automatic feed-water

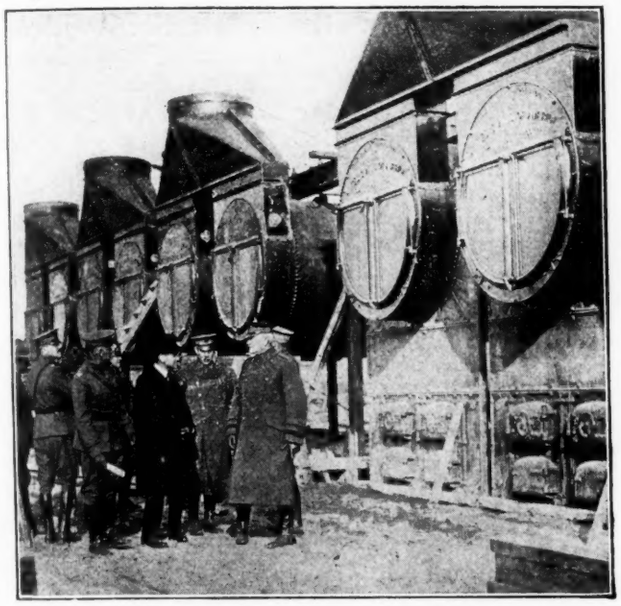


FIG. 3. GENERAL PERSHING INSPECTING POWER PLANT DURING CONSTRUCTION

regulators are used. Water from the feeders is delivered to the mains through an air chamber. A 3-in. cold-water connection having an injector at each boiler also is provided. A 5-in. suction pipe connects the pumps with the hotwell of the barometric steam condenser, which has an 18-in. exhaust pipe running to it. Fig. 3 shows General Pershing and Secretary of War Baker inspecting the power plant.

Refrigeration is by direct expansion of the ammonia circulating in coils hung from the ceiling of the building, which is divided into five rooms, each with a capacity of about 1000 tons of meat. Means are also provided for storing vegetables and other products at a higher temperature than is maintained in the meat-storage rooms. As an indication of the size of this plant it may be noted that for the refrigerating coils alone 30 miles of 2-in. pipe was required.

While the original plans for the manufacture of ice, as distinguished from the provisions of refrigeration in the meat-storage rooms, have been modified for a small output, the plant is nevertheless equipped to produce ice. In the ice-making building there are six freezing tanks, each with a capacity of 62½ tons daily. The freezing tanks contain a solution of brine cooled by 26 miles of 1¼-in. iron pipe.

In the construction of the refrigerating plant 4,000,000 ft. of lumber, equivalent to about 6000 tons, have been used. Insulations for the cold-storage rooms, roofing paper, insulating paper and brick for the boiler settings represented a tonnage of 2600, while 2000 is the weight of the mechanical equipment of the plant. Then, too, there are items of 400 tons of salt and 200 tons of ammonia, including the weight of the drums in which it is shipped. Summing up, the refrigerating plant represents a tonnage of 11,200. This figure is important, when it is recalled that practically everything that entered into the construction of the plant had to be shipped from the United States. In addition, concrete for footing walls, engine foundations, etc., was required, most of the cement for this purpose having been obtained from Europe. Exclusive of the cost of transportation from the United States, itself an item of no mean magnitude under present conditions, the refrigerating plant represents an outlay of more than $2,000,000.

Obviously, such work as that required for the installation of a large plant of this kind could have been handled only by specialists. This fact was appreciated last year, and while the designs were being prepared at Washington there was organized a so-called Ice Plant Company of engineers of about 350 men, most of whom were recruited from the personnel of the large packing companies of the Middle West. Work on the refrigerating plant was started in France in December, 1917, but the promise, by those in charge of the installation, that operation could be begun in five months, was regarded with skepticism in some quarters. Nevertheless, in spite of all the difficulties that surrounded construction work in France in these days, this promise was fulfilled ahead of schedule, and the placing of the plant in operation on May 2 of this year is a splendid tribute to the men of the Ice Plant Company. Fig. 4 is a view of the loading shed.

In explaining to me the plans for the refrigerating plant, which were prepared under the direction of the Cantonment Division of the Quartermaster's Department, now known as the Construction Division, a major

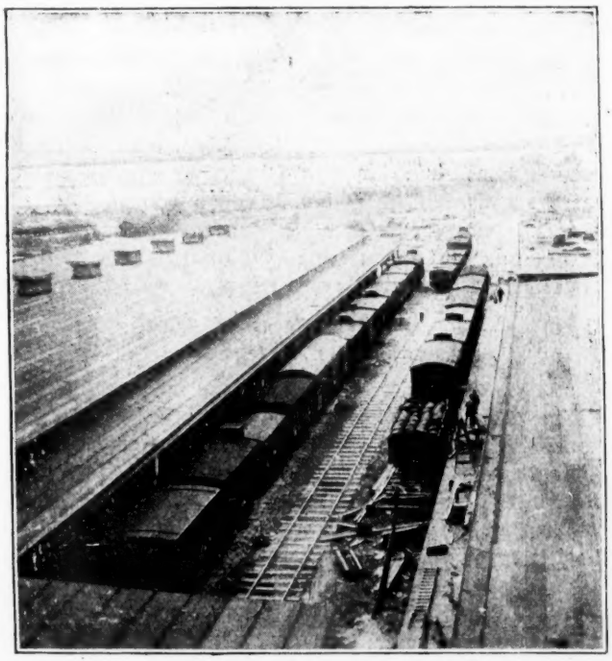


FIG. 4. VIEW OF THE LOADING PLATFORMS

of the Quartermaster's Corps, who is an expert on refrigeration, mentioned a few of the outstanding features of the design. Unusual pains have been taken to insure flexibility in the layout of the piping. A break in the piping would be serious, especially here where ammonia losses cannot be so easily replaced as in the

United States. Horizontal return-tubular boilers were selected because of the ease of installation and the convenience of shipment. The ammonia lines are sectionalized by the introduction of valves at frequent intervals. In case of a break a section of piping may be cut out of the system, and ammonia losses thereby reduced.

Provision is made for the use of exhaust steam for distilled-water ice which may be needed for special purposes.

By maintaining a zero temperature in the freezing rooms, and allowing meat to remain there four days before shipment, it will be possible to dispense with special refrigerating cars and to forward the frozen meat in plain box-cars. This feature of the plant operation is an exceedingly important one, in view of the present car shortage in France and the undesirability of introducing special cars for special purposes.

The cross-compound duplex ammonia compressors are 19 x 36 x 24 x 46 x 36 in., and the vertical single-acting compressors are 21 x 28½ x 32 in. The ammonia condensers are of the atmospheric type. Those used for the cross-compound machines each have banks of 15 coils, while those used for the vertical single-acting machines each have banks of 10 coils each. There is one 9 x 9 x 11½ x 10 in. inclosed pump-out compressor. The water-supply line to the ammonia condensers is 12 in. in diameter. Here provision is also made for the salvaging of oil. Fig. 1 is a view of the refrigerating building taken from the roof of the ammonia condenser plant. The feature of the plant, so far as the layout of this building is concerned, is the use of a long low single-story structure rather than a more compact building of several stories, as is common elsewhere. The advantage of the layout adopted is that long trains can be quickly loaded and unloaded. The main refrigerating building, measuring 896 x 112 ft., will accommodate 25 freight cars on each side. The successful completion of the refrigerating plant is due in no small measure to the precautions taken in America in crating, marking and shipping of the multitude of mechanical parts required. At Washington the delivery of the material ready for shipment abroad was controlled by charts, and shipments were well coördinated, and the machinery arrived in France when and as needed.

A Puzzling Gas-Engine Trouble

BY P. A. GETT

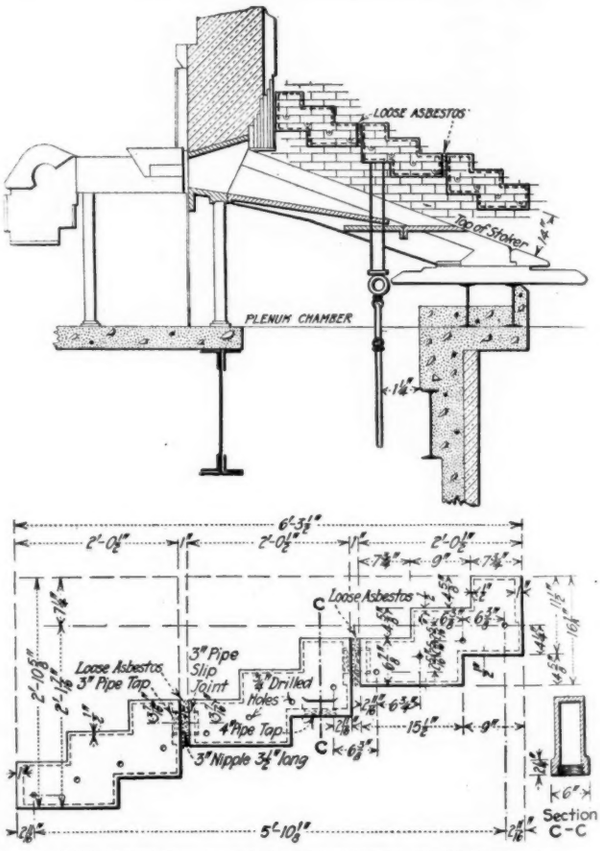
The writer was recently sent to correct serious trouble with a two-cylinder opposed tractor engine. Several mechanics had worked on this same engine hunting for the trouble, and acting upon their advice, the owner had bought a new carburetor, taken the high-tension magneto to an electrical shop a time or two, spent a lot of good money in various other ways and almost exhausted his patience as well.

The examination proved that the valve setting was badly out of time, and this was about all that could be found wrong with the engine. The camshaft gear had to be moved thirteen teeth to bring it to the proper time. The motor was started and came up to speed nicely, but after running for about half of a minute, it gradually slowed down and stopped. It was cranked for some time, but would not come to speed again; it would fire only once in a while weakly.

The timing was checked and the magneto found correct, but the valves were wrong again. This proved that something was slipping, and reasoning from the fact that the magneto was driven from the camshaft gear and was still correct, the trouble sifted down to the camshaft slipping in the gear. Taking the camshaft and gear out, holding the shaft with a pipe wrench and turning hard on the gear with the hands proved this diagnosis correct. The crescent key was sheared off and the setscrew let the shaft slip and get out of time slowly, which made it difficult to locate the trouble. A new key was put in place and after adjusting the new carburetor the engine pulled its usual load with ease.

Side-Wall Clinker Prevention

The formation of clinker at the side-walls of furnaces and the difficulty of removing them when formed is one of the most troublesome experiences of boiler operation, besides being a serious factor in keeping high



AIR BOXES TO AVOID CLINKER STICKING TO FURNACE SIDE-WALLS

the maintenance cost on settings. To reduce trouble of this kind at the River Station of the Buffalo General Electric Co., the air-distribution boxes have been put along the side-walls of the furnaces of the Babcock & Wilcox cross-drum boiler; the furnaces have underfeed stokers. A 4-in. pipe is connected to one of the air-distribution boxes, which are all connected together. Into this 4-in. pipe a 1¼-in. steam line is led to act as an inspirator; the steam jet, discharging into the 4-in. pipe, draws air into the open end of that pipe. Three-quarter inch holes are drilled into the side of the box facing the furnace. The illustration gives dimensions and details.

Combustion Control Meter

In order to obtain the best results from a boiler plant, certain conditions must be met. Not only must the surface of the boiler be clean, but the baffle walls must be in proper shape to prevent the short-circuiting of the gases and the volume of air must be regulated so as to maintain the correct supply for proper combustion. Numerous devices have been applied to the boiler-room operation for controlling the draft and thereby regulating the air supply.

One method of furnace control is by means of a furnace meter or pyrometer placed where desired in the boiler setting. The installation consists of a special hollow tile for inserting in the furnace bridge-wall, an indicating pyrometer for placing on the boiler front and a recording pyrometer for the engineer's office, together with the necessary thermocouples. Such an arrangement of instruments and bridge-wall tile has been developed by the Combustion Control Co., 2 Rector St., New York City. Fig. 1 shows the application of the thermocouple and the hollow tile to the bridge-wall of a boiler, together with the wiring to the pyrometer. The principle of operation is as follows:

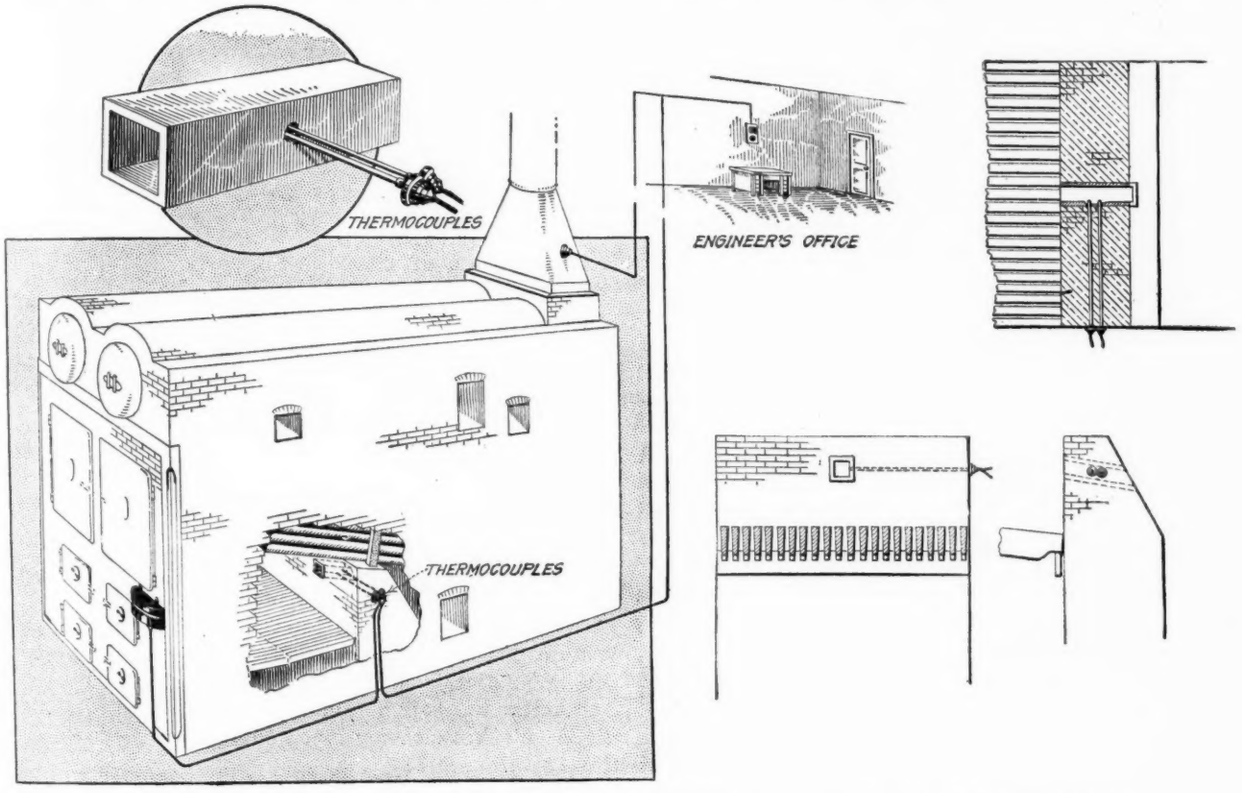


FIG. 1. DETAILS OF THE SYSTEM AND THE APPLICATION OF THE TILE IN THE BRIDGE-WALL

The hollow self-cleaning tile is placed in the center of the bridge-wall and near the top, as shown in Fig. 1. Hot gases from the furnace are bypassed through the passage in the bridge-walls to the rear of it. A hole is provided in the side wall of the furnace and extends to and into the hollow tile, and in it two thermoelectric base-metal couples are inserted. The shape of the interior opening at the one side of the hollow tile is shown in the plan view in the detailed illustration. This keeps the ends of the thermocouples out of the direct path of such flames as may tend to pass through the tile, and also prevents an accumulation of fine ashes in the pockets and around the couples.

One of the couples is connected to an indicating pyrometer, Fig. 2, that is placed on the boiler front, and the other is connected to a recording pyrometer placed in the engineer's office or at some other desirable point. This instrument is mounted on a panel, together with a 20-point rotary switch. The figures shown on the switch (Fig. 3), from 1 to 10 inclusive, are red and indicate the bridge-wall temperature of ten boilers. A second set of contact points, 1 to 10 inclusive, are for the uptake on ten boilers and are white. An indicator shows which switch is closed. By this arrangement reading can be had of either the bridge-wall or the uptake temperature as desired.

When a furnace meter indicates the temperature, it also indicates in an approximate manner the output of the boiler. With the damper wide open the maximum volume of gas passes through the furnace. If there are holes in the fire, this volume is cooled and the pyrometer will register a lower degree of temperature. If the grate is clogged, the volume of air is reduced and the temperature is reduced, which is also registered on the chart of the recording pyrometer. Therefore, a high temperature registration on the chart not only indicates the degree of furnace efficiency, but gives a check on whether the boiler is producing a high or a low output.

The temperature graduations of the chart shown in Fig. 4 are in hundreds. The high peaks represent high furnace temperature. The chart record is composed of dots that are made at intervals of 30 seconds. When the furnace is fired at a point below the peaks,

less heat is lost and the average temperature is maintained at a high point. These dots show just what is taking place in the furnace.

The furnace meter gives a comparative temperature record of the gases in the furnace and the actual temperature of the gases in the uptake. The record of the uptake gases indicates the following: Temperature

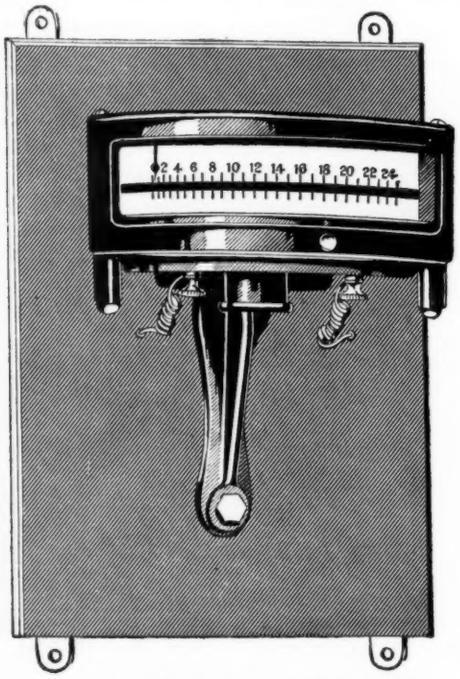


FIG. 2. INDICATING PYROMETER

showing that the boiler conditions are normal. A high temperature shows one or all of three conditions; namely, dirty tubes, a hole in the baffles or excess of coal per square foot of grate surface. Low temperature indicates leaky setting, poor fuel or abnormal draft.

The record of the bridge-wall gases by comparative temperature shows the condition of the fire as indicated by the temperature line and spacing dots on the chart, the quality of coal used, method of firing the furnace and the opening and shutting of the damper.

If a continuous record is desired for each boiler, a two-thread recorder supplements the twenty-point switch and registers the actual temperature in the uptake and the comparative temperature at the bridge-wall. A multiple-record pyrometer of six records, for groups of three boilers, can be used. The advantages of this are a reduction in the number of record sheets to be cared for, a saving in first cost of equipment and a saving in the expense of record sheets.

If a pyrometer is placed in the uptake of the boiler, it provides a check of the heat given up in the furnace by the fuel and the amount of heat absorbed by the boiler. It is evident that this metering equipment informs the engineer what is going on in the furnace of the boiler, and it also shows the opening and closing of the damper and enables him to know how the firemen are performing their duties. Furthermore, it gives him a record of the quality of the fuel burned, because one lot of coal may average a certain furnace temperature of so many degrees and another lot may fall below that average. The chart shows the time of firing, the operation of the draft, the frequency of cleaning the fires, etc. On stoker-operated furnaces the meter will record when the most efficient point of operation has been reached.

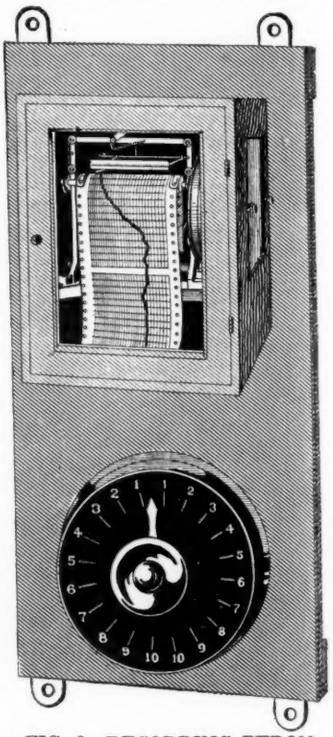


FIG. 3. RECORDING PYROMETER AND 20-POINT SWITCH

When an engineer has learned to read the chart, he can direct the fire from a central point. The straighter the line maintained at the highest average temperature the better the firing. Having data supplied, the engineer can effect economy that would otherwise be difficult to obtain.

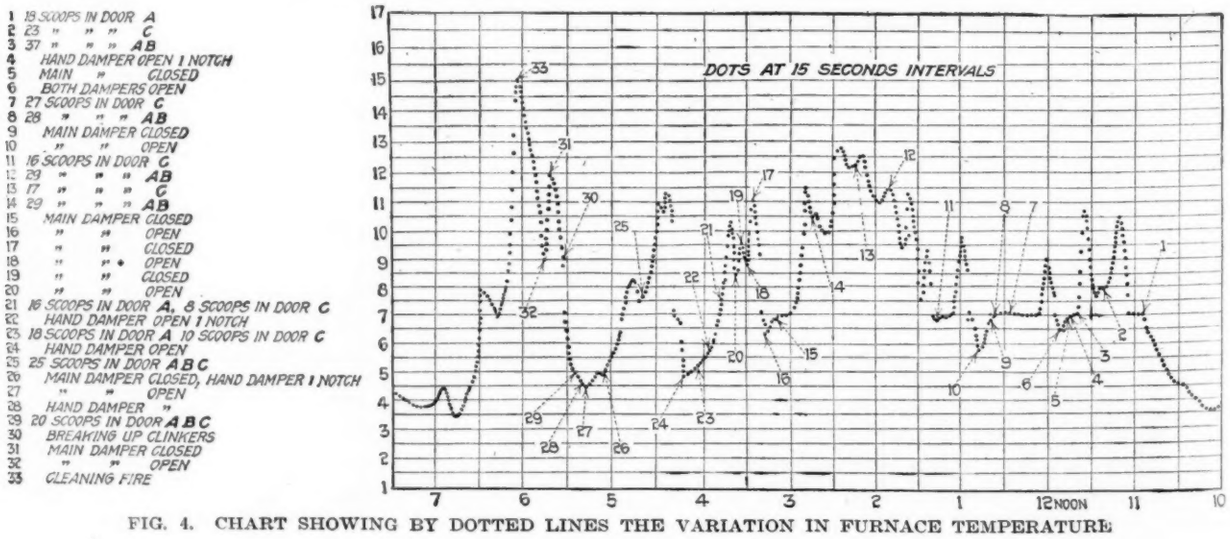

1 18 SCOOPS IN DOOR A
2 23 " " " C
3 37 " " " AB
4 HAND DAMPER OPEN 1 NOTCH
5 MAIN " CLOSED
6 BOTH DAMPERS OPEN
7 27 SCOOPS IN DOOR C
8 28 " " " AB
9 MAIN DAMPER CLOSED
10 " " OPEN
11 16 SCOOPS IN DOOR C
12 29 " " " AB
13 17 " " " C
14 29 " " " AB
15 MAIN DAMPER CLOSED
16 " " OPEN
17 " " CLOSED
18 " " OPEN
19 " " CLOSED
20 " " OPEN
21 18 SCOOPS IN DOOR A, 8 SCOOPS IN DOOR C
22 HAND DAMPER OPEN 1 NOTCH
23 18 SCOOPS IN DOOR A 10 SCOOPS IN DOOR C
24 HAND DAMPER OPEN
25 25 SCOOPS IN DOOR ABC
26 MAIN DAMPER CLOSED, HAND DAMPER 1 NOTCH
27 " " OPEN
28 HAND DAMPER "
29 20 SCOOPS IN DOOR ABC
30 BREAKING UP CLINKERS
31 MAIN DAMPER CLOSED
32 " " OPEN
33 CLEANING FIRE
DOTS AT 15 SECONDS INTERVALS
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
7 6 5 4 3 2 1 12 NOON 11 10

FIG. 4. CHART SHOWING BY DOTTED LINES THE VARIATION IN FURNACE TEMPERATURE

The Uptake Damper

By Charles H. Dromley

Engineers and firemen of steam plants have got to save the greatest part of fifty million tons of coal this year. Perhaps no other operating condition will do more to accomplish this saving than correct use of the uptake or "back" damper in the steam boiler. The following is intended for those who may not appreciate how important it is to use this damper properly.

Let us consider a few fundamentals:

To burn coal, oil or any other fuel, air is necessary. The more air is pushed or pulled through a good bed the more fuel will be burned in a given time. For any given amount of coal a certain quantity of air is required to completely burn it, theoretically and practically. All the air above that quantity just necessary to burn the coal on the grate does no good, but does do harm because it gets heated from the temperature of the boiler room to the temperature of the gases going out the uptake and carries this heat away up the stack.

Suppose the air in the boiler room is at 70 deg. and that the gases leaving the boiler are at 600 deg. F. Suppose that the weight of flue gas coming out the uptake is 40 lb. per pound of coal burned instead of 20 lb., which would have been enough to burn the coal economically. This is a condition that exists every day in many plants. Then for every pound of coal burned 2544 B.t.u. have been wasted; or about one-fifth of every ton shoveled into the furnace was wasted simply because too much air got into the furnace. Figure it out yourself: $(600 - 70) \times 20 \times 0.24 = 2544$ B.t.u. The 0.24 is the specific heat of a pound of flue gas, or air, or the number of heat units necessary to raise the temperature of one pound of flue gas, or air, one degree.

Have in mind that it does not matter whether this more-than-enough air, this excess air, comes in through the fuel bed, around the edge of it, or through cracks in the furnace walls—however it gets in, it causes a serious loss of coal.

Here is where the uptake damper comes in. In the average plant this damper is kept open too much and the ashpit doors are opened and closed to regulate the draft. When this is done, the furnace is under a partial vacuum, the pressure inside is less than that of the air in the boiler room, and air rushes into the furnace by way of every crack and crevice, through the fire-doors that do not close tightly, through the large front and back doors and through cracks and pores in the brickwork. If the ashpit doors do not close tightly, if there are leaks in the walls below the grate, the fire burns more rapidly than you want it to. This is particularly the case during light loads, sometimes frequently blowing the safety valve, as you doubtless have experienced.

All this is avoided if the draft is regulated by the uptake damper. Get the habit of using it.

Have the handle used for opening and closing the damper located on or near the boiler front, and provide so that you can open and close it to get fine regulation of draft.

Each boiler has a draft gage on the boiler front, or certainly should have. Now if you can buy or borrow an Orsat or CO_2 analyzing apparatus, and carefully collect samples of flue gas through the open end of an ordinary pipe from the very middle of the gas stream at the uptake or where the gases just leave the heating surface, it will be but a short while until, by CO_2 and draft observations, you will learn how to regulate the uptake damper, how thick to carry the fire and what draft to use to make the most steam with the least coal.

Maintaining the Accuracy of Thermometers

By M. A. Saller

One of the simplest and cheapest, and yet one of the most vital instruments in the power plant, is the ordinary mercurial thermometer. Thermometers can be used to great advantage for the measurements of temperature wherever considered of importance, such as boiler feed, condensing, cooling and return water, on steam lines, for checking steam pressures, flue-gas temperatures, etc.

Notwithstanding the simplicity of these instruments and their widespread use, it will be found that many thermometers are not giving accurate readings for one or more of the following reasons: (1) The wrong type; (2) improperly installed; (3) accumulation of foreign matter on the thermometer well; (4) separation of the mercury in the column; (5) breakage due to careless handling; (6) incorrect adjustment of the reading scale.

1. It is highly important for good results that a thermometer be selected which has a suitable temperature range. The smaller the range of temperature to be covered the greater the accuracy that can be obtained. For feed water the average range of 50 to 220 or 60 to 240 deg. F. is employed. For condenser service a range of 30 to 160 deg. is usually sufficient. For superheater work the range should be from 200 to 800 deg. For very high temperatures the ordinary mercurial thermometer is unsuited, and some form of pyrometer should be used.

2. Incorrect readings are common when the thermometer well or bulb does not come in full, constant contact with the liquid or gas being observed. Care should be exercised to see that the bulb or well is placed in a part of the line or tank that is not pocketed or at a dead end. In pipe lines the thermometer should be placed so that the well at all times is fully immersed in the flow. Thermometers placed in tees or elbows are liable to be isolated from the current and give incorrect indications. Care should also be taken to so place the thermometer that it will not be unduly influenced by heat from outside sources. Ordinarily, thermometers are calibrated at living-room temperatures, and if installed in a very hot location, say on a boiler front where the temperature may be 150 or 200 deg., it is obvious that the expansion of the mercury will be greater and cause a higher reading. Thermometers are also subject to error or misadjustment if connected with or to vibrating pipe lines.

3. In ordinary practice one of the most frequently encountered causes of inaccuracy is the presence of mud, scale, oil or other foreign matter on the well or bulb of the thermometer. In most cases this accumulation cannot be prevented, therefore the thermometer should be removed from its socket from time to time and

the well and bulb inspected and cleaned. This feature should be carefully watched where scale is liable to accumulate.

4. The separation of the thin mercury column often accounts for a high reading. If the mercury column becomes separated, it can usually be reunited by firmly holding the thermometer at the top and giving it a quick jerky throwing movement outward, tending to throw the isolated column toward the well or bulb. Where the column cannot be united in this way, the condition can be remedied by applying heat to the bulb, which will drive the main body of the mercury up the column until it reaches the separated portion, unites with it and carries it back upon cooling.

5. Most commercial thermometers are supplied with iron or brass cases fitted with a square or hexagonal nut at the base for screwing the instrument into a tapped opening. This nut affords a means of attaching the thermometer without imposing a strain on the instrument itself, but in many cases is overlooked and the body of the case is used, with the result that not infrequently the thin glass tubing is broken. This break often occurs in the base of the thermometer and as some mercury remains in the tube the damage is frequently unnoticed. Where thermometers are installed in exposed places or in open passageways, they should be protected by some sort of shield or guard.

6. In most thermometers the graduated metal scale is made separate from the tube and hence any movement of either will naturally throw the readings off. The scale is usually provided with a slot and screw to permit adjustment to agree with the calibration. Where any question arises as to calibration, whether a thermometer is correctly adjusted, a simple test of the freezing and the boiling points can be quickly made. The freezing point is readily obtained by packing around the bulb of the thermometer a quantity of finely broken ice in such a manner that while the tube is entirely surrounded by the melting ice, it does not rest in any of the water resulting from the melting. After remaining in the ice pack for five to eight minutes, the location of the mercury column will indicate the freezing or melting point, which is 32 deg. on the Fahrenheit scale. To ascertain the boiling point, the thermometer bulb is placed in a vessel containing boiling water or directly above in such a manner that it registers the temperature of the steam being liberated to the atmosphere at the boiling point. After holding it in this position for a few minutes the height of the mercury column will indicate the boiling point.

Stoker Installations as Agencies in Coal and Iron Conservation

An ingenious set of figures showing the saving of coal and iron effected by the installation of underfeed and traveling-grate stokers has been compiled by the Combustion Engineering Corporation. The data on which the figures are based were obtained by sending out questionnaires to plants in which Coxe and Type E stokers had been installed and then analyzing the answers, which covered 31 different cases. The adoption of stoker firing resulted in a saving of a total of 396,861 tons of coal per year, which was an average of approximately 30 per cent., and the labor saving averaged 46 per cent. On the basis of 50 tons per carload, the 396,861 tons of coal saved is equivalent to 7937 carloads; in other words, the railway systems of the country have been relieved of a yearly burden of 7937 carloads.

It has been established by numerous tests that boilers fitted with Type E and Coxe stokers may be run continuously at an average of 200 per cent. of normal rating. Stated in another way, this means that the adoption of stokers enables one boiler to do the work of two, and so saves the material and labor that would be required in the construction of the extra boiler. The 31 plants represent a total of 72,570 rated boiler horsepower, and it has been calculated that approximately 165 lb. of pig iron is required per rated horsepower in steam-boiler construction. By obviating the use of 72,570 additional boiler horsepower, therefore, a saving of $165 \times 72{,}570 \div 2000 = 5987$ tons of pig iron was effected, enabling this material to be diverted to urgent war work.

Owing to the establishment of a zone system of coal distribution, railroad hauls are not so long as they used to be. Assuming that the average haul is 200 miles, the tonnage of coal saved per year represents $200 \times 396{,}861 = 79{,}372{,}200$ ton-miles. Similarly, assuming an average haul of 150 miles for the pig iron, the saving amounts to $150 \times 5987 = 898{,}050$ ton-miles. The sum of these two products is 80,270,250 ton-miles, which is removed from the annual freight traffic of the country, enabling the cars to be used for more vital purposes. Assuming that one locomotive is able to haul 100 cars of 50 tons each, the saving amounts to 16,054 locomotive-miles per year. As one of the great difficulties of railroad transportation during the past year has been the scarcity of cars and locomotives, it is apparent that these reductions are of no mean importance.

The table gives a summary of the answers to the questionnaire and shows the data on which the foregoing estimates are based. In the two cases in which a saving of 100 per cent. of coal is noted, the installation of the Coxe stoker made possible the use of waste fuel produced by the manufacturing plant itself and costing nothing but the slight expense of handling to bring the fuel to the boilers.

DATA USED IN FINDING SAVING OF COAL AND IRON

Number of Case	Type of Stoker	Number of Stokers	Labor Saved, Per Cent.	Coal Saved, Per Cent.	Coal Saved, Tons	Rated Boiler Horsepower	Freight Saved, Carloads
1	E	4	30	25	4,600	1,474	92
3	E	6	.....	20	1,790	2,100	36
6	E	2	50	10	383	600	8
8	E	6	60	10	800	1,308	16
11	Coxe	20	50	100	210,000	12,000	4,200
15	E	6	.....	3	2,000	1,836	40
16	E	1	25	10	27	518	...
17	E	3	.....	20	2,250	1,800	45
21	E	14	50	10	6,570	6,250	131
27	E	7	10	10	4,905	2,800	98
29	E	16	50	25	12,000	4,000	240
32	Coxe	4	.....	100	25,290	1,650	506
34	E	8	.....	15	2,896	1,900	58
35	E	3	33	10	13,014	750	260
37	E	12	85	15	10,038	7,000	201
41	E	1	.....	25	1,695	355	34
48	E	4	.....	...	3,600	1,188	72
51	E	4	.....	10	428	1,072	8
52	Coxe	2	30	...	17,520	1,000	350
54	Coxe	12	50	8	6,167	4,400	123
56	E	2	50	6	447	500	9
59	Coxe	8	50	...	2,630	2,410	53
62	E	10	50	25	7,540	2,412	151
64	Coxe	2	.....	15	1,050	880	21
65	E	4	.....	20	3,275	1,500	66
66	E	2	None	20	624	700	12
68	E	2	.....	10	730	1,000	15
71	E	29	.....	10	8,440	4,875	169
72	Coxe	3	50	...	25,280	1,500	506
73	E	3	.....	10	872	792	17
75	E	4	50	10	20,000	2,000	400

EDITORIALS

Saving Paper a Duty

THE American public has been told many times over that America as a nation is wasteful. This war has proved the assertion to be correct. Waste of any useful material at any time should not be countenanced, and under existing conditions, when the transportation facilities of the country are so severely taxed, and when manufacturing plants are working at full blast in order to supply the requirements of the Government and of the people as a whole, the little wastes occurring here and there seriously interfere with the production of essentials.

The majority of our readers will doubtless claim that they are not wasteful, and firmly believe that they are not. Let us see. Take the single item of paper. Recently, the War Industries Board applied to the business press to use its influence to educate the users of paper to be economical. Paper is so common that few have given a thought as to how and of what it is made. The amount of coal that is yearly consumed in its manufacture, the number of cars and locomotives that are used in its transportation and the various chemicals that are employed in its production, have been given but little thought by the average citizen. And yet these items all enter into the making of paper. Every pound of coal burned, every locomotive and car used, and every pound of chemical and wood consumed is just the amount that could be diverted to other essentials where it is so badly needed.

It is said that one pound of paper wasted represents about two pounds of coal wasted. Every ton of paper wasted represents a like tonnage of needed supplies that could be handled by the transportation lines of the country. Every pound of paper wasted means that another pound must be manufactured to take its place.

Perhaps the engineer does not have the same opportunity to save paper as does the office worker, the merchant or those engaged in other pursuits, but he can do his part. A man buys a newspaper, takes it home and reads it. It is then probably burned in the kitchen range to get it out of the way. Papers collect surprisingly fast, and after newspapers are read they should be saved and sold to the junkman, who will dispose of them, and they finally will be returned to the mills and made into a different grade of paper.

It requires four tons of material in all to manufacture one ton of paper. One cord of wood makes one ton of mechanical pulp, and two cords of wood are required to make a ton of chemical pulp. About one ton of coal is used in the manufacture of one ton of paper. Every ton of paper that can be manufactured from old papers saves wood and the necessary power and labor to convert the wood into pulp. A cord of wood suitable for paper manufacture costs more than twenty dollars.

Thousands of pounds of paper is taken to the boiler rooms of the country every year to be burned, just to get rid of it. Much of this could be used for scratch pads, etc. This is not done because it is not so handy as using a block of prepared paper. The saving by a single individual does not make much of a showing, but every little helps to make a large total. Therefore save the paper.

The Committee on Man-Power Engineering of the National Americanization Committees has issued a circular in which it is pointed out that nearly every business house mails a certain amount of printed matter in large unsealed envelopes, and also receives a large amount of such material in similar envelopes. These were relatively cheap before the war, but now they are hard to obtain and cost considerably more. In order that the envelope may be used again, a label has been suggested to paste over the original address, thus making the envelope as good as new so that it can be reused. While it would seem petty economy to save envelopes in normal times, it is a patriotic duty today. Paper means coal, labor and transportation. These are factors that will help win this war. When paper is saved, it means more coal for our battleships, transports and essential industries. As for the money saved, the committee suggests that it be invested in a Liberty Bond or two.

Where Some Older Engineers Are Helping

IN ORDER that the industrial life of the nation may go forward at the pace necessary for winning the war, it is incumbent upon workers in countless fields to do more than their bit in their daily tasks. In many cases, indeed, they are called upon to do the utmost possible within their powers. In a fine spirit many older men have come to the front ranks of industries as the younger men have departed for the military and naval stations, both old and young determined to give all that is in them to the great cause which all patriots and lovers of world liberty have so much at heart. This means that not a few engineers who have long since left their days of routine duty and more ordinary tasks are taking up the young man's burden at home and, adding his duties to their own, are devoting themselves heart and soul to doing things that must be done and done well if the boys at the front are to be adequately backed up.

We see heads of firms doing certain necessary work at the drafting table, waiting on customers here and there, placing themselves at the beck and call of the Red Cross, of Liberty Loan committees, working without compensation in fuel-saving campaigns, and in numerous other ways lending their abilities and strength to the home needs. Here is a chief engineer who stands watch in his turn because of a depleted staff, and here is another who takes up burdens of inspection on a regular basis instead of relying upon the reports of subordinates needed in other duties. Another chief takes upon himself a large amount of the clerical work formerly handled by a young man now in the army, perhaps doing his own typewriting and curve plotting,

helping out the purchasing agent's correspondence, and in general putting himself into the service of his organization without a thought of his executive prerogatives and erstwhile dignity.

There are some splendid things coming out of this war! And it will be many a long day before the knowledge of what teamplay will accomplish will be overcome by a narrow individualism. Surely, it may be believed that out of the stress and strain of these tremendous days will come a sense of brotherhood in all professions and industries which will forever do away with the dog-in-the-manger ways of the past. Our older engineers who are assuming the humbler tasks so uncomplainingly and so unselfishly are doing their part to bring in a new era of mutual service in technical industry. They are drawing upon the reserves of their strength in order that the home fires of industry may be kept burning, that production may not slacken in this hour of need. Some of them, indeed, are risking their lives in carrying loads normally too great for their physical strength and nervous energy. They will pay the price of today's overwrought labor in shortened years, but they will pay it gladly. Hats off to these patriots of the throttle and the indicator, and more strength to their driven bodies and burdened minds as they do their work in these glorious days and nights—let us not forget the nights—of service!

Another Teutonic Boomerang

THE events of the last four years, both in Europe and in our own country, have taught us how utterly devoid of honor are the German people. We have seen so many instances of shameless perfidy, deliberate breaking of solemn pledges and repudiation of promises and agreements that we should no longer be surprised by further evidences of their moral turpitude. Nevertheless, we cannot repress a feeling of anger and contempt whenever some fresh example of their unscrupulousness is brought to light, even though it has become almost proverbial that their every attempt to perpetrate some new fraud or indignity upon neutral or enemy is foredoomed to react on them with tenfold force.

Previous to the outbreak of the war, Germans had taken out in the United States numerous patents dealing with the manufacture of chemicals, among which were a number for the production of nitrates from the air. After the declaration of war by our country, the attempt was made to use certain of these patented processes for obtaining nitrates. They failed completely, for the simple reason that the German patentees, with their customary mental obliquity, had purposely neglected to state all the essential data.

Fortunately, American chemists were equal to the occasion and were able to discover the missing links, so that the processes became workable. But an investigation of other German chemical patents revealed the fact that they were defective in the same manner and that the processes could not be applied successfully in the form in which they were patented.

Of course, the intentional omission of necessary details renders the patents invalid and as a consequence there is a strong possibility that a general cancellation of German patents in this country will follow. Further than that, if the processes worked out by American chemists should be patented, the Germans would be put in the predicament of having to pay royalties in the United States on chemicals that they were the first to manufacture. Thus retributive justice makes a boomerang of the diabolical cleverness of a people whose sense of honesty is permanently warped.

And such is the sort of conscienceless scum that asks to rub elbows with men of decency and integrity around a peace table!

An Hour in Which To Be Cautious

IT IS the morn of a momentous day, it seems. The vaunted invincibility of Germany has tumbled, and a man who not long ago was a quiet, almost obscure professor, dictates the end of the mightiest and blackest dynasty of modern times. And this with a pen in the solemn silence of a study three thousand miles away on another continent. Truly, for some the world is out of joint.

The peace for which the nations of earth yearn is in sight, though perhaps out of reach. Peace will come and as the Allies dictate it. It must be so. The cost has been too great for anything less. It is not for military commanders to decide political questions; but they will continue to force back, capture and annihilate the enemy until an armistice is reached, and then they must maintain their stupendous organizations in readiness for a renewal of hostilities until peace ends hostilities.

Do not imagine that all this would transpire in a short time even were conditions most favorable—and they are, at this writing, anything but that. That our armies may press every advantage and gain others, that they may be maintained in readiness for any emergency, they must continue to have supplies and in increasing quantities. We of the industries must fight harder than ever. To do so is to keep the enemy reeling and the sooner force him to collapse. For power-plant men this means an increased vigilance to avoid troubles that might mean a shutdown; it means the most earnest search for places where and means whereby fuel can be saved. Upon power industry depends, and upon industry our armies feed. The President separately announced on the day he answered Germany's last plea that we would continue to send two hundred and fifty thousand troops to France every month.

Get an Indicator by Using an Indicator

THERE are only a few more days in which to win those prize indicators. They are to be awarded for the most meritorious application of the indicator, one to a steam engine and the other to an oil or gas engine, pump, compressor or any use other than upon a steam cylinder. A planimeter will be awarded as a second prize in each case. Charles T. Main, president of the American Society of Mechanical Engineers; David Moffat Myers, Advisory Engineer to the United States Fuel Administration, and George H. Barrus, chairman of the A. S. M. E. Power Tests Committee have consented to act as judges. Send an account, with diagrams, of your most successful use of the instrument to *Power* before November first, having it attested if possible by the owner or manager of the apparatus involved.

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellow-engineers how you have saved coal. "Power" will pay for good articles that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

Boiler-Room Efficiency

I wish to call attention to some errors in the paper by A. H. Blackburn, "Boiler-Room Efficiency," presented before the meeting of the Smoke Prevention Association in August of this year, and published on page 437 of the Sept. 17 issue of *Power*. In that paper Mr. Blackburn recommends stokers as the best method of firing and classifies them under three general types—overfeed, underfeed and chain-grates.

The representatives of underfeed-stoker interests are given to expressions about overfeed type of stokers, especially since the experts of the Bureau of Mines, Mr. Randall and Mr. Weeks, in their report of investigations, as published in Bulletin No. 40, page 48, speak of "stokers of the side overfeed type." This has the merit of indicating which type of stoker is meant, although there is and never has been an overfeed stoker of the sidefeed type.

I have been familiar with the various types and makes of stokers that have attained to any considerable use during the last thirty-five years. The only overfeed mechanical stoker I ever knew or heard of was of the flirt-the-coal type which scattered the fuel over a flat fuel-bed surface. Hand-firing is always overfeed unless it is by what Mr. Blackburn designates as "the coking method," which, as he says, consists in placing a charge of coal on the front part of grate and, after it is coked, pushing it back and again filling up on the front of the grate. Mr. Blackburn further says truthfully that the coking method, if well done, gives the least smoke, and he might as truthfully also have said, the best economy. That coking method is exactly the process of feeding and coking the coal by a sidefeed stoker. The mechanical feed, however, is much more regular, and the coking is accomplished more rapidly and more efficiently than is practicable by hand-firing.

I challenge any man to give an intelligent reason or basis for designating the sidefeed type of stoker as an overfeed type. I also challenge Mr. Blackburn's statement that "with an overfeed stoker the covering of green coal" prevents the heat from the fuel bed from reaching the top of the fire and therefore heat loss occurs. Mr. Blackburn must know there is no "covering of green coal" on the fuel bed of a sidefeed type stoker, and he must also know that there is and must be an updraft of air through the fuel bed of what he is pleased to call the overfeed type. If the heat is not carried up through the fuel bed, it certainly will very quickly burn the grates and put the stoker out of commission.

The fact is that the radiant heat of the fuel bed on the grates of a sidefeed-stoker furnace is carried to the heating surface of the boiler and more of it is efficiently applied than is possible with the underfeed type. At least one form of sidefeed stoker is self-cleaning as well as self-feeding, and there are no "times when the fires are being cleaned," and therefore no waste of heat by rush of cold air through openings for cleaning.

Mr. Blackburn should stick to the well-known and well-worn facts, such as those of which the greater part of his paper, here referred to, consists, or at least get the facts about the operation of the underfeed stoker and refrain from attempting to designate types or describe the characteristic operation of other or competitive forms. He should also refrain from writing about "making the *boiler* smokeless."

Dayton, Ohio. O. D. COTTON.

Twin Strainer Connection

On page 343 of *Power*, Volume 30, 1909 will be found the progenitor of the twin strainer connection (except for the style of strainer) shown on page 501 in the issue of Oct. 1, 1918. Several such connections for 42-in pipe had been used on a water-works job some years prior. Whether used before or not the writer does not know. ALONZO G. COLLINS.

Philadelphia, Penn.

Hydrostatic Lubricator Regulation

Referring to A. L. Noe's letter on page 430 in the issue of Sept. 17, telling how to make the drops of oil fed by a hydrostatic lubricator large or small, I am wondering why it should be either necessary or desirable to alter the size of the drop. It is a wrong notion that the delivery outlet of the lubricator located in the steam pipe gives off the oil in impulses equal to the volume of the rising drop. This wrong idea leads to the conclusion that the smaller and more frequent the drops the more uniformly will the oil be mixed with the steam.

The truth is that the oil is liberated into the steam pipe in a fine unbroken stream like that passing through the needle-valve of the sight feed. This is easily proved by a simple experiment. Carefully bleed enough water out of the sight glass to bring the solid oil down within sight and watch the action of the rising drops. A little study will show that while each drop is building on the feed nozzle, its steady expansion raises the water level by a like volume, forcing oil into the steam space at the same uniform rate. Then, when the drop rises from the nozzle, it only exchanges places with so much

water and incorporates with the oil above, lowering the water level by the amount it had been raised during the formation of the drop.

Thus, it is seen that changing the size of the drops can in no way affect the regulation or action of the lubricator. Of course a large drop forming in a small glass is more likely to "smear" the glass.

Vancouver, B. C. Canada. R. MANLY ORR.

Saving Money in the Boiler Room

Referring to the editorial, "Saving Money in the Boiler Room," page 535 of the Oct. 8 issue of *Power*, one sentence reads as follows: "When it comes to CO_2 apparatus, temperature-recording gages and steam-flow meter, etc., these are appliances which the owner does not believe to be necessary," etc.

As the whole purpose of the Fuel Administration is to save coal, it would seem that the very foundation of coal saving is to ascertain how much coal is fed to each individual boiler. For example, steam-flow meters are only useful in fuel conservation, broadly speaking, if the weight of fuel burned to produce a given amount of steam is available for comparison. In order to determine the amount of coal burned in a given time some type of weighing scale is necessary.

The Fuel Administration seem to consider the weighing of coal and the recording of its weight as of greater relative importance than you do in your editorial, for the first two questions in the questionnaire are: (1) What provision is made for weighing fuel used each shift or day? (2) What records are made of fuel used each shift or day?

Therefore do you not think that apparatus for weighing coal as it is fed to each furnace should have been enumerated and not merely left to close the procession under the vague alias of "etc."? F. ODONE,

Passaic, N. J. Advertising Manager,
Richardson Scale Co.

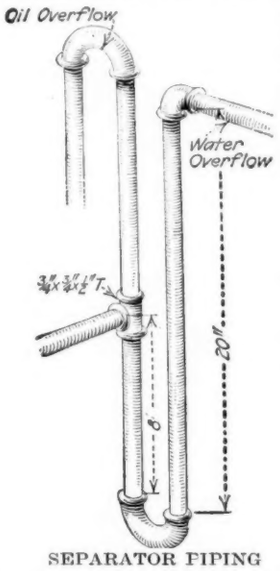
[Certainly, coal-weighing apparatus should have been mentioned in connection with the devices named in the editorial, together with a number of others on the market of various types which assist in the economical operation, if the intent had been to enumerate all of them. The thought in the paragraph under discussion was to bring out the fact that some of the smaller plant owners care nothing about economy, their idea of plant operation being to keep the engine running.

All plant owners are interested in the amount of coal burned, but many of them depend upon the weight provided by the coal dealer as the coal is delivered to the plant, or, as is often the case, a small platform scale is used for weighing wheelbarrow loads as they are wheeled into the boiler room. The owner is therefore interested in weighing scales of one kind or another.

Unfortunately, as intimated in the editorial, a large number of plant owners require education as to the value of the various instruments that will enable them to check up the performance of their plants. Many of them hold the mistaken idea that the installation of recording instruments of various types is so expensive that the results obtained would not justify the investment in their particular plant. Of course, such a view of the matter is in most cases erroneous.—EDITOR.]

Home-Made Oil and Water Separator

In our plant the steam-driven air pump located on the engine-room floor has a gravity oiling system. The oil, along with the condensation from the stuffing-box on one end of the cylinder, drains into the base and thence through a drain pipe into the basement. For about seven years this mixture was caught in a pail and emptied into the sewer as the oil, about a pint to a pailful, was not considered worth bothering with. After taking charge of the plant, I made an oil and water separator, of old ¾-in. pipe and fittings picked up about the plant, as shown in the illustration. It works on the principle that, water being heavier than oil, a column of water will balance a higher column of oil; therefore as the mixture of oil and water flows in at the tee and the piping becomes filled, the oil will naturally rise in the vertical pipe immediately above the tee, forming a column higher than the water overflow pipe. The operation will then be continuous, the water flowing from the one opening and the oil from the other. There must be an opening at the high point of each drain to avoid siphoning. Since this rig has been in use we have saved about seven gallons of oil per month.



SEPARATOR PIPING

Hoquiam, Wash. C. COZENS.

All-Around Blundering Conduct

Permit me to express my sentiments of disgust regarding the situation (based on imagination rather than fact, I hope) described by J. J. Jahobart in the issue of Oct. 15, page 568. I hope, too, that the intent of the writer was not to convey the impression that "Warner" was the only fool connected with that particular plant.

The circumstance developed the fact that "Warner" did not possess right and manly basic principles. He did have the right idea in going to the operating chief and, failing to get an answer from him, then to the assistant superintendent for an explanation. In all probability his reception by the latter was not such as to encourage him to go to the "high and mighty" superintendent. At any rate it would occur to "Warner" that he had gone as far as was prudent. His big and really criminal mistake was in abuse to the machinery and a blind (blindfolded) striking out at his fellow employee. The manly thing for him to have done would have been to resign, stating in writing just why he did so. So much for "Warner," but how does the other side of the picture look?

Behold a Kaiser! So far apart from and above an ordinary operating engineer that he assumes the right to order him about without giving him one little glimpse into the secret chamber of his "mighty mind" to reveal the small part of the plan so vitally concerning the (should be?) groveling serf. Rot! Such conduct

on the part of a man who perhaps by accident of close connection with someone else in a position to help him does not by any means prove personal superiority, nor does any position carry with it an inherent right to disregard the human rights of a fellow employee.

It is of course contended by those who exercise arbitrary authority that it is necessary to have discipline and that acceptance of certain employment carries with it an implied agreement to perform any and all duties assigned. Granting that there are such conditions implied and necessary under some circumstances, they certainly do not apply in a case such as that cited where a "day-turn" job has been bargained for when first employed or later earned by reason of long service or good work. The employee has earned the day turn as truly as he has earned his week's pay and has just as much right to it. It is to wipe out just such imperialism in international affairs that the World War is being waged. It will no doubt take longer to eradicate the horde of petty tyrants of everyday life who are making so many thoroughly and uselessly miserable than it will to bring about a semblance of decency in the political world. Neither will become permanent, however, until the evil is exterminated from the individual mind and heart.

I have no doubt "Warner" would have performed his night duty and the work of breaking in new men cheerfully and much better if he had been "tipped off" as suggested in the editorial note at the close of Mr. Jahobart's article. By the way, the name attached to the article does not convey to me any impression as to the nationality of the author, but it is a "safe bet" that he has at least been trained under the servile rule of "do as you are told and don't question the right of it," and thinks that the procedure of the superintendent was correct. "Warner" I am pleased to note is a little farther advanced in civilization than either the author or superintendent in that he went part way in the right direction—but his courage failed before going all the way. He then reverted to a barbarous and unreasoning desire to "get even with somebody" and to do so mistreated the machinery in his charge.

Let the notion that employees are cattle to be driven, which is the attitude of too many when they find themselves in positions of some authority, pass away along with imperialism and its many festering appendages.

J. LEWIS.

New York City.

Power Plant Generalities

In connection with the question, "Why does the water in a boiler disappear during the night?" it may be suggested that when we start a fire under a boiler with cold water we usually have two gages of water, but when we get steam up to 100 lb. or more the water in the glass has increased in height to three gages and sometimes more. Where does this increase come from? If it is due to expansion from the temperature, it is reasonable to assume on the other hand that a decrease of temperature will produce a lower water level.

It should be pointed out to the new fireman or water tender that in renewing a water glass, screwing up hard on the gland nuts will put a twisting strain on the glass, but making the glands up as tight as you think they should be, then unscrewing them a small part of a turn to relieve the twisting strain on the glass, will save many a "hot time" and also add to the life of the glass.

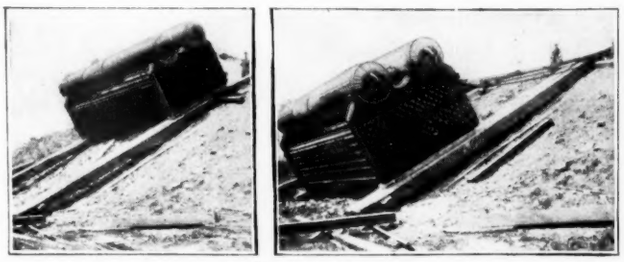
Coal conservation is one of the best things that has come about through war conditions, and I hope it will continue long after war ceases. Two years ago the ash in the coal supplied to the power plant averaged 16 to 18 per cent.; last winter it went as high as 40 per cent. What we get now is somewhat better, but "hangs around" 30 per cent. There is something slack besides coal, and I hope that it will be properly investigated and the cause removed so that we will get good coal. Now is the time the country needs the best—leave the culm piles till after the war. I consider it an unpatriotic act to supply an inferior coal because the Government has set a price per ton, when there would be a good profit when supplying the best from the mine.

J. C. SCHENCK.

Brooklyn, N. Y.

Difficult Boiler Installation

The illustration shows the difficulty that was encountered in installing boilers in the new addition to the power plant of the Clinchfield Portland Cement Co., Kingsport, Tenn. The main feature of this installation is that there will be a large combustion chamber for



SKIDDING A BOILER DOWN A STEEP BANK

each boiler, made possible by the use of a Dutch-oven furnace in which the stoker is installed. Placing the boilers over the foundations was accomplished under unusual difficulties. After the boilers were bricked in, the stokers were erected and bricked in. The brickwork in front of the boilers being toothed made it possible to secure tight joints in the stoker setting.

St. Louis, Mo. C. C. MULDNER.

Pointers on the Care of Gage-Glasses

Perhaps a little more on the subject of breaking new gage-glasses may prove acceptable. Having had some years' experience as sort of "emergency repairman," I naturally have learned a lot about such matters. Eight years ago I took my present position, and the very first day I had a gage-glass break and three more broke before I got one to hold. At the first opportunity I took out and cleaned the fittings thoroughly, being careful when replacing them to get them fairly in line.

I use a good quality of glass and soft-rubber rings, just set up the nut "hand-tight," and never break a glass when replacing them. I always open the upper valve first and let the steam blow gently through the drain-cock until I think the glass is about the same temperature as the water in the boiler; then I open the bottom valve slowly before shutting off the drain-cock.

We carry 95 lb. steam pressure, and I renew the glass at each annual inspection, but have not had a glass break in service for three or four years. I am in favor of gage-glasses of small size and have often substituted ½-in. for ¾-in. glasses and invariably found it advantageous. There is no advantage in a large glass—a half-inch glass is just as reliable a guide to the water level if given proper attention, and a larger glass is equally worthless if it is not kept clear. Another thing I have learned by experience is not to let the glasses come in contact with iron or steel before installing. When I was going to sea I always made a wooden rack consisting of two little brackets with holes the size of the glasses, in which to keep them handy for use.

Philadelphia, Penn. J. W. LEA.

Oil and Grease Trap

Considerable oil can be saved in the course of a year in many plants if all drains or drips that contain any oil at all are intercepted before being discharged to

OIL INTERCEPTED ON ITS WAY TO THE SEWER

the sewer by some such a grease or oil trap as that shown in the illustration. The construction of the trap is simple and inexpensive and its operation is satisfactory. JAMES E. NOBLE.

Portsmouth, Ont., Canada.

Pipe Stoppages in New Heating Systems

I am interested in what was said in the issue of Oct. 1, page 488, regarding pipe stoppages in new heating systems, particularly in reference to the application of "dope" to pipe threads in making up a joint. It is many years since I have done this work myself, but the method taught to me was never to dope the fitting but always the outside thread and to do this intelligently. As a matter of fact, I believe there are more joints made up with the dope applied to the fitting because it is the handiest to do. In the first place, by doping the fitting there is more chance of getting in too much than too little, and when the pipe is screwed in all the surplus "dope" is forced to the end of the pipe where it comes in contact with such iron cuttings and core sand and dirt in general as may have lodged in the pipe and remained there concealed until this fitting is made up, when it is worked out of the recesses and mixed with the "dope," which soon hardens and is in such a position as to cause trouble.

Some years ago I protested to the head of a pipe-fitting department doing work for me, where this method of doping the fitting instead of the pipe had been adopted and his reply was that it was their general practice and he considered it a good one. I then said that not a single fitting could be made up for me with dope inside of the fittings. The remark made by this head of a pipe department quite staggered me, and the incident has dwelt with me ever since and has been brought to mind whenever I have had occasion to construct a piping system of any kind, employing men from different shops. I can conceive of no reason why the practice of doping a fitting should be permitted to continue and yet to stop it means that we would have to wait until the present generation has died off and in the meantime apprentices must be taken in hand and taught the proper way; and I am inclined to think that a penalty would have to be imposed if they did their work otherwise. O. C. EWAN.

New York City.

Why Does the Water Disappear?

On page 315 of the Aug. 27 issue of *Power* is a letter by E. W. King, entitled "Why Does the Water Disappear?" From time to time there have been discussions published relating to this subject, and it is one well worth while. After all of the auxiliaries are shut down and the fires are banked, if there are a few leaks along the steam line, stuffing nuts leaking at the valve stem, etc., I do not know of a better way of determining that these leaks exist than to watch the water level disappear in the boilers. When steam is on the line, these same leaks are going on all the time and they are always growing larger. Steam leaking around the valve stem cuts them and this, of course, makes it difficult to keep them tight. If a leak develops at the stuffing nut on a valve stem, stop it.

When the plant is shut down and the fires banked and all throttle valves on the various units are closed, there is generally a separator, placed above the throttle, which is under steam pressure. These separators are drained through a steam trap which discharges the condensate to the heater in some cases, in others into the sewer, and in others the water is discharged back to the boiler, where it should go. As the units are shut down, the steam lines leading to them act as a dead end and, consequently, condensation occurs and the steam trap relieves the separator of the condensate and discharges, as has been said, in many cases to the sewer, where it is lost.

At the same time the trap may be blowing through, creating another heavy drain on the boiler. The boiler-room attendant, noticing that the water is getting a little low and that the boiler is cooling off, puts more water into the boiler and breaks up the fires a little so as to keep up the pressure, but the leaks go on just the same. C. R. REYNOLDS.

Oklahoma City, Okla.

A big power project has been planned by Philadelphia interests in conjunction with the United States Shipping Board, it is reported. The plant will cost approximately $14,500,000.

INQUIRIES OF GENERAL INTEREST

Distribution of Engine Friction—In a balanced slide-valve steam engine how is the work that is lost by friction distributed? W. L. G.

In average cases the relative distribution of the friction is about as follows: Main bearings, 47 per cent.; piston and rod, 33 per cent.; crankpin, 6.5 per cent.; crosshead and wristpin, 5.5 per cent.; valve and rod, 2.5 per cent.; and eccentric strap, 5.5 per cent.

Judging Completeness of Combustion from Appearance—How can the completeness of combustion of furnace gases be distinguished by their appearance? D. L.

When complete combustion is taking place, the gases, while still in a flaming state, are transparent. When the air supply is insufficient, the combustion space is filled with opaque gas or smoke. The character of the combustion may be judged by observing the gases through a violet-blue glass. When perfect combustion is viewed through such a glass, the interior of the furnace and the fuel present a lavender-gray color, while flames in a state of imperfect combustion present the appearance of dark-colored gas.

Increase of Chimney Capacity from Greater Height—What percentage will the capacity of a chimney that is 80 ft. high be increased if it is raised to a height of 100 ft.? W. H. P.

For the same temperature of chimney gases the draft pressure is directly as the height and velocity of the chimney gases, and therefore the relative capacities of the chimneys with the same size of flue, will be as the square roots of their heights; that is, in the ratio of $\sqrt{80}$ to $\sqrt{100}$, or as 8.944 to 10. Hence to raise the height from 80 to 100 ft. should increase the capacity $(10 - 8.944)\ 100 \div 8.944 = 11.8$, or about 12 per cent.

Hard and Soft Boiler Patches—What is the difference between a hard and a soft boiler patch? A. D.

A hard patch consists of a piece of steel plate that is accurately shaped and permanently riveted to place. A soft patch is generally one that is applied temporarily or in case of an emergency and is not supposed to constitute a permanent repair. The material usually is wrought iron shaped to fit the required place by hammering cold and set in boilermaker's putty or with a lead gasket and secured in place by threaded patch bolts, which are setscrews with a countersink under a square head that is chipped off after the bolts are screwed into place.

Equivalent Evaporation with Steam 90 per Cent. Dry—If a boiler produces 8.2 lb. of wet steam at 110 lb. gage per pound of coal from feed water at 80 deg. F., what is the equivalent evaporation from and at 212 deg. F. if the steam is 90 per cent. dry? W. R.

According to the steam tables, a pound of dry saturated steam at 110 lb. gage, or 125 lb. absolute, would contain 1190.3 B.t.u. above 32 deg. F., that is, 315.5 B.t.u. in the water and 874.7 B.t.u. latent heat of evaporation; but if the steam is 90 per cent. dry, a pound would contain only 315.5 + 90 per cent. of 874.7 = 1102.73 B.t.u. above 32 deg. F. Having the feed-water temperature 80 deg. F., or 48 deg. above 32 deg. F., each pound of the steam must have received 1102.73 — 48 = 1054.73 B.t.u., and as evaporation from and at 212 deg. F. requires the latent heat of evaporation, or 970.4 B.t.u., the equivalent evaporation from and at 212 deg. F. is $8.2 \times 1054.73 \div 970.4 = 8.91$ lb. of water per pound of coal.

Testing Superheat of Steam Supplied to Engine—What is the proper method of determining the number of degrees that steam delivered to an engine is superheated? R. F.

Superheating should be determined by means of a standardized thermometer placed in a mercury well inserted in the steam pipe near the engine. Manufacturers of thermometers supply mercury wells that are made with standard pipe threads for insertion in a hole tapped in the top or side of the drum or pipe containing the steam to be tested. The degree of superheating should be taken as the difference between the reading of the thermometer for the superheated steam and the reading of the same thermometer for saturated steam at the same pressure. The readings for saturated steam can be obtained by insertion of the same or a duplicate mercury well in the steam drum of the boiler, pipe or other connection in which there is circulation of saturated steam of the same pressure as the pressure supplied to the engine.

Striking at Both Ends of Duplex Pump—What causes a duplex pump to strike at both ends of its stroke? W. V. H.

Striking at both ends on one side of the pump occurs at slow speeds when there is too much lost motion of the steam valve. If the valve is operated by a single nut on the valve rod between lugs on the slide valve, then to reduce lost motion a thicker nut should be substituted. If the valve is picked up by jamb nuts on each side of a lug on the valve, the lost motion is reduced by setting the pairs of jamb nuts nearer together. On large pumping engines, the amount of clearance is provided on the outside in a lost-motion link with adjustable tappets. If striking at both ends occurs only for higher speeds, there is insufficient cushioning on the exhaust. This may be due to leaky piston rings that do not hold the exhaust ports tight when the piston is near the ends of its stroke, or if the pump is provided with cushion valves, they may leak so badly as to lose the cushion.

Height and Shape of Bridge-Wall—Should the top of the furnace bridge-wall of a return-tubular boiler be flat on top, or curved to match the curvature of the boiler shell; and what governs the amount of opening to be left between the top of the wall and the boiler? W. G. B.

According to tests the shape of the bridge-wall, whether level on top or curved to correspond with the shell of the boiler, or whether the sides of the wall are vertical or sloping, appears to make little difference. The bridge-wall is primarily for the purpose of preventing the fuel from falling off the grates and for forcing the air to pass up through the fuel bed. The cross-sectional area of the space between the top of the wall and the boiler should be large enough not to check the draft and for that purpose should be at least as large as the combined area of all of the flues. Although a narrow space over the top of the bridge-wall results in better mixture of the gases, more complete combustion is hindered by the cooling effect of the boiler-heating surface and the boiler shell is likely to become burned.

Pump Trouble from Air Leakage of Suction Connections—Trouble is experienced with racing of an 8-in. pump that until recently ran very steadily. The pump valves and all working parts appear to be in good condition. What is the probable cause? M. B.

It is likely that the suction pipe, or connections, have developed an air leak, the location of which may sometimes be detected from the sound of air rushing into the pipe. If the pipe is accessible, a leak or hole can be discovered by going over the suction with a lighted candle when the pump is running. Inrushing air will divert the flame toward the hole in the suction pipe if the candle is held near enough. If the suction pipe is covered, to test for leakage, blank off the ends of the pipe, fill it with water and with a pressure test gage and hand force pump attached, ascertain whether the suction pipe will hold about 20 lb. pressure; or determine whether a head of water can be maintained without replenishment in a small standpipe connected to the suction pipe and extending not less than 35 ft. above the level of the pump.

Report of Committee On Automatic Heat Control*

The purpose of this paper is to discuss automatic temperature regulation, particularly in its effect upon fuel conservation. There are many appliances on the market for securing automatic temperature regulation. We may, therefore, consider that automatic temperature regulation is a commercial success, and that the various methods of securing it are effective in the particular field for which each was designed. It is believed unnecessary in this report to describe the mechanism.

SUCCESSFUL automatic temperature regulators make for economy of fuel, since they shut off the heat supply whenever the desired temperature has been attained, turning the heat on again only when the temperature drops. The heating apparatus must be capable of maintaining a temperature of about 70 deg. when the weather outside is at its coldest. Since such low outside temperatures exist for a comparatively small part of the heating season (probably only about 10 per cent. of the heating season) it follows that during the greater part of the season the heating apparatus must be operated at less than full capacity. There is therefore a constant tendency to overheat during mild weather in all classes of buildings. The results of overheating on human efficiency and health are profound, and within the comfort limits, overheating is more common and carries more harmful results than underheating. The elaborate mechanism for automatic temperature regulation in the bodies of mammals and the serious results of very slight failure of this regulation to function properly should indicate the wisdom of all practicable exterior measures to assist.

Automatic Regulation Necessary to Economy

In all the buildings or inclosed spaces there will be some heat given off the bodies of the occupants, from processes carried on, or from the sun. Unless very careful attention is given to any system of manual temperature control, these additional supplies of heat will cause an unnecessary and undesirable temperature increase. It is fair to say that the introduction of automatic temperature regulation is the only practicable means of realizing the saving in fuel to be made by utilizing to the fullest extent these independent heat supplies. The importance of correct humidity control must not be lost sight of in considering temperature in its bearing on human activities and comfort as the two are most intimately correlated. The ability to control within very close limits the moisture content of air is necessary in many manufacturing processes, and so intimate and remarkable are the results following the automatic control of moisture in such cases that we believe that along this line the future holds wonderful possibilities. The temperature of all domestic hot-water supplies should also be controlled automatically, as not only waste in fuel and rapid deterioration of valves and packing, but serious scalding may result from overheated water. By domestic supplies is meant all water used for lavatories, laundries, baths, etc., whether in homes, offices or factories.

Manufacturing plants in general, the country over, however heated, are without automatic temperature regulation and when overheating causes discomfort, doors and windows are opened but very seldom is the heat shut off, which would, if done, reduce materially the coal consumption. Too often such neglect is based on the idea that exhaust steam is of no value, although in making it about nine-tenths of all the fuel burned was required, and in wasting it this nine-tenths is wasted. Automatic temperature regulation is at present vitally responsible for increased efficiencies in manufacturing processes, particularly as regards the saving in time and labor, for the application of automatic temperature regulation in manufacturing plants usually results in the release of labor to be used for other purposes.

Only a few, certainly not over one in ten of the residences in this country have automatic temperature regulation, despite the very simple and inexpensive devices which, operating on the draft dampers of the heaters, will prevent any overheating and will even insure the maintenance of a reduced temperature during the night without any special adjustment. A fair share of public buildings are equipped with automatic temperature regulation, particularly those having mechanical ventilation. This is not only because fuel economy is sought, but also because with such ventilation very rapid air changes are necessary and manual temperature control is impossible.

Probable Savings by Automatic Control

Where automatic temperature control is installed, the device is in operation, limiting the emission of heat and the waste of fuel, for fully one-half of the time during the heating season. This does not mean a fuel saving of 50 per cent. of course, since all heating plants react rather sluggishly to the conditions in the building. With electrical heating, the saving is nearly directly in proportion to the hours turned off. With steam heating there is a constant heat loss from the pipes, and when the steam is turned on a cool radiator, the rate of condensation momentarily is excessive. When steam is turned off from all the radiators or a large percentage of them, the pressure at the boiler increases rather slowly, and while such pressure increase is reflected ultimately in the rate of fuel consumption, it may be many minutes after the radiators are closed. With hot-air heating in residences, for instance, where the temperature is controlled by the draft damper, even though the draft be decreased it will take some minutes for any decreased combustion rate to be manifest. Observations of many different types of automatic temperature control, under varying conditions, and all available tests of such systems indicate strikingly that in order to maintain closely any fixed temperature there must be an almost continuous movement of the dampers or valves. Such persistent and continuous adjustment by hand is well-nigh impossible. Following are some well-authenticated records of actual savings:

1. Test by F. A. DeBoos in Kansas City, Mo., in an office building, heated by direct steam. (Proceedings of The American Society of Heating and Ventilating Engineers.) The steam was shut off 63 per cent. of the time between 8 a.m. and 6 p.m. during February, with an average outside temperature of 29 deg. although the temperature inside was maintained at 70 deg. These observations also indicated that the valve must be opened and closed about 2500 times during a heating season to hold the room temperature within one degree from the point desired.

2. Simultaneous tests of the temperature and condensation of two buildings of practically equal size at the University of Illinois (Prof. A. C. Willard) show a consistent *decrease* in the amount of steam required by the automatically controlled building as the outside temperature *increased*, while the manually controlled building became too warm as the outside temperature increased, with very little decrease in the amount of steam used. A saving of 17 per cent. of the steam required was made at the university by maintaining 70 deg. rather than 75 deg. The exact percentage of saving possible is difficult to prove.

3. Consistent observations extending over many years, by the boards of education at Toledo, Ohio, Erie, Penn., Kansas City, Mo., and other places where buildings of similar type and size are equipped with similar heating systems but with and without automatic temperature regula-

*This report by the Committee on Automatic Heat Control (Samuel R. Lewis, chairman), of the American Society of Heating and Ventilating Engineers was intended for presentation first at the January (1919) meeting of the society but is released for publication in advance in the interest of fuel conservation and the general good. The committee hopes that it will receive the widest publicity. It has already been placed in the hands of the Fuel Administration and the Bureau of Mines.

tion, show an average saving of about 15 per cent. of the total fuel consumption per season by using automatic temperature regulation.

4. The introduction of automatic temperature regulation to street cars, as shown by tests made by the Chicago Railways Co. and which, since electric heating was used, were easily computed, show a saving, by preventing overheating, of well over 50 per cent. This saving computed on the basis of 3 lb. of coal per kilowatt-hour means, for the 50,000 electrically heated cars in the United States, a saving of nearly 750,000 tons of coal per season.

5. A two weeks' test was conducted in a residence at Overbrook, Penn., supplied by a central heating plant. The first week the plant was operated under hand control and required an average of 2180 lb. of steam per day (measured by condensation). During the second week the house was under automatic control, and the average amount of steam consumed per day was 1500 lb. During these two weeks the average outdoor temperature was practically the same. This shows a saving, therefore, of 680 lb. of steam per day, or at 50c. per 1000 lb., 34c. per day (American Radiator Co.). The saving is over 31 per cent.

6. F. W. Ballard, in a paper read before the Ohio Society of Mechanical and Electrical Steam Engineers, describes a central heating plant operating at Cleveland, equipped with automatic temperature control. To quote from his statement: "This has been found in some cases to reduce steam consumption by as much as 25 to 30 per cent."

7. Automatic temperature regulation installed on the heating plant in the First National Bank Building at Peoria, Ill., showed a saving of approximately 33⅓ per cent. in a test extending over a period of eight months as compared with the corresponding months of the previous winter. The test was conducted and the statistics were compiled by H. R. Wetherell, of the National District Heating Association. The net saving in this building for the year was $158.95, which was considerably more than the cost of the very simple, self-contained type of automatic control installed.

8. H. A. Woodworth, Merchants Heat and Light Co., Indianapolis, Ind., made a seven days' comparative test on a building with and without automatic temperature regulation, and developed a saving of about 35 per cent. in steam consumption through the introduction of the regulating equipment.

9. A large store at Hartford, Wis., heated by steam from a central station and so having ready means of measuring the condensation, saved nearly $200 in one season by installing a single unit automatic temperature regulator.

Cost of Automatic Control Installed

The cost of installing automatic temperature control to an existing plant varies, of course, with the conditions. In manufacturing buildings, it is often possible to control a large number of heating units in the same room with one thermostat. While perhaps not so minute regulation will thus be accomplished, a general condition will be attained of preventing overheating. Where the building is considerable in size and has many rooms, a system of regulation having many units—such as the type using compressed air as motive power—or an electrical system, is least expensive and most satisfactory. With its control of each unit of radiation, varying the amount of heat as the varied exposure and heat source conditions of the building require, such a plant must reach a high efficiency. Maintenance seems to cost annually not to exceed 2 per cent. of the cost of the plant. For buildings having but one or two rooms, and for residences of reasonable size, however heated, single unit regulators, which may be self-contained, or electric or mechanical, give satisfactory results and the maintenance cost is negligible. It may be roughly stated that a good system of automatic temperature regulation may be installed in a building for from 5 to 10 per cent. of the cost of the heating plant.

The installation of automatic temperature regulation, or systems for prevention of excess temperature, is a justifiable investment for all heating systems inasmuch as it very positively contributes to conservation of fuel, improvement in health and gain in personal efficiency. Those installations in which it is particularly a desirable and wise addition are: All manufacturing plants in which a temperature of 60 deg. or higher is maintained; all offices; all residences (for the smaller residences the type that has but one thermostat, operating on the heater drafts, gives excellent results); all buildings heated from central stations, and particularly those having steam service (for many of these the single-unit type of control is ample); all buildings having mechanical ventilation (the air changes are so rapid and involve such quick temperature fluctuations that automatic temperature regulation is imperative from the comfort standpoint as well as for many other reasons); all service hot-water heaters, particularly those having coils which are supplied with steam (the saving to be made is great, prevention of scalding is positive, steam supply to the coils, or the drafts of the coal-fired heater, or the supply to the gas-fired heater may be controlled by automatic devices limiting the temperature of the water); all manufacturing processes in which exact control of the moisture contained in the air and the temperature of any of the materials is of importance.

For data incorporated in this report acknowledgment is due to E. V. Hill, of the Chicago Department of Health, to A. R. Root, of the American Radiator Co., Chicago, and to H. W. Ellis, of the Johnson Service Co., Milwaukee, Wis.

Turbine-Driven Alternator Burned Out

The following details of the accident to the 12,000-kv.-a. three-phase 60-cycle 11,000-volt turbo-generator in the Reeves Avenue Station of the Virginia Railway and Power Co., Norfolk, Va., have just been received from H. Root Palmer, general superintendent of light and power. The accident occurred at 4:45 on the morning of July 26, just before the daily load started to come on, the entire load

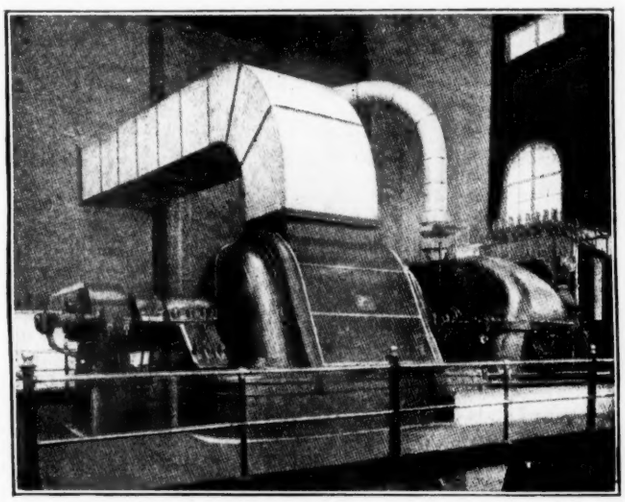


FIG. 1. SHOWING AIR DUCT LEADING FROM GENERATOR

at this time being about 6000 kv.-a. carried on this unit, the night load having dropped off. Fig. 1 is a reproduction of a photograph of the unit taken shortly after its installation. The air duct, leading from the generator to the boiler room, is shown.

The accident consisted of a short-circuit at the terminal blocks and a breaking down of the insulation at the ends of the armature coils where they extended beyond the slots. The cause of the short-circuit seems to have been the escape of steam into the basement from a 2-in. union that failed, on a bleeder line from the main steam line to a trap, this steam finding entrance into the casing of the generator by way of the ventilating duct. The air for the generator ventilation is taken from outside the building, brought to the generator through a masonry duct constructed on the turbine-room side of the division wall separating the turbine and boiler rooms, shown in illustration, Fig. 2, and

discharged through a galvanized duct by natural draft into the boiler room above the boilers.

The main steam header is along the division wall, on the boiler-room side, the turbine connection being taken off above the boilers, passing through the division wall directly to the turbine. Near each end of the main steam header there is a drop-leg to the boiler-room basement with a steam trap at the lower end. The steam for the auxiliaries is taken off a short distance above the bottom of the drop-leg. All large connections to the main steam header are equipped

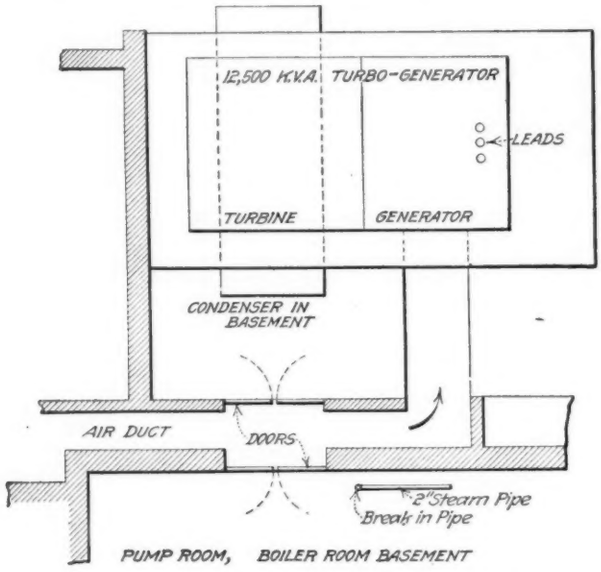


FIG. 2. PLAN OF AIR-INLET DUCT IN BASEMENT

with hydraulically operated valves, the control being located in two banks, one of which is near each drop-leg in the boiler-room basement. The pressure carried is 190 to 195 lb., with an average of 140 deg. superheat.

The failure occurred in a 2-in. union in a pipe between the bottom of the drop-leg and the steam trap, near the bank of control valves, and about six feet from a bulkhead door (for removing condenser tubes) in the wall of the air duct leading to the generator. The bulkhead door, of insurance specifications, was a close fit, with only slight inequality in the masonry work at the bottom, due to wear.

Upon opening the generator, the three leads were found to be burned free from the terminal blocks, the lugs entirely melted, as well as about a foot of the 1,000,000 cir. mil cables. The terminal blocks were almost entirely burned away. The insulation on the ends of the coils was so badly burned that it could be easily brushed away.

The heat from the burning insulation, fanned by the ventilating air, also damaged the end shield and the lamination for some distance from the end.

Saving Coal by Use of Daylight

The War Industries Board estimates that the large lighting companies of the country can effect a saving of about 100,000 tons of coal as a minimum figure, by the continuation of the daylight saving law throughout the winter. Alexander Dow, president of the Detroit Edison Co., Detroit, Mich., which city has already experienced a year of the daylight-saving practice, states that under the old régime, they had winter peaks of 15 per cent. and upward in excess of the loads at other seasons and that this necessitated 15 per cent. or more capacity in power houses and in cables leading out of the power houses in excess of that required during the other hours of the year, and the total time of these peaks approximated 100 hours per annum. With the change made in 1915 in Detroit, advancing the time one hour, the evening peaks disappeared and the narrow morning peaks that appeared were very much less in relative size and have been carried without difficulty.

Liability in Case of Bursting Water Gages

By CHESLA C. SHERLOCK

The use of steam as a motive power has caused certain appliances to be used in connection therewith in the intention that accidents might be reduced to a minimum. But even these appliances oftentimes prove to be the cause of injury. For instance, gage-glasses are known to burst at times without warning and sometimes without any apparent cause. When a gage-glass explodes it frequently showers fine bits of glass in the immediate vicinity. If a workman happens to be within its range of effectiveness, he is liable to receive cuts, or, as many of the cases disclose, lose one or both eyes.

Bits of glass driven under the power of steam into the eyeball generally means the loss of sight. In addition, the workman is oftentimes severely burned about the face and body by the escaping water.

In order to remedy this situation, safety appliances have been devised to place around the water gage, the intent being to prevent flying glass in case the gage explodes; but many workmen grow careless and remove them, forgetting to replace them. The numerous instances of injuries which workmen are receiving almost daily in power plants when a water gage explodes are shown by the number of instances in which the courts have been called upon to consider cases of this nature.

Employers are oftentimes aware of the defective condition of water gages and their protective screens, but they put off replacing them, through neglect or otherwise. In the interval, the defective condition of the appliance asserts itself with the result that a workman is injured.

Take for instance the Arkansas case in which a fireman in a power establishment noticed that the guard to a water gage was in a defective condition. It seems that this particular guard was composed of metal strips set a slight distance apart. One morning the fireman noticed that one of these strips was missing. He called the attention of the chief engineer to it, saying that it ought to be fixed, as it was dangerous in its present condition.

The engineer replied: "I am going to have it fixed in the morning." This the engineer did not do, and several days later the fireman again complained of it to the engineer.

It seems that there were several boilers in this establishment and that the fireman did not work upon the same one all the time. Some time later he was called to work on night shift and directed by the engineer to work upon the boiler having the defective screen. When the fireman again examined the screen or guard he found that it had not been fixed.

He again called the engineer's attention to it, saying: "Now, I have told you about that as much as I am going to tell you, and if you don't have it fixed at 12 o'clock, I am not going to work on this boiler," adding that it would not take more than two minutes to fix the guard. The engineer replied that he surely would have it fixed at once.

The fireman then went out to his supper and when he returned, he was standing by the boiler, striking a match, when the water gage exploded and steam and water blew into his face and eyes. This happened at about 12:50 and was the first time the fireman had been near the boiler since he had announced his determination to quit at 12 o'clock if the gage was not fixed and he had received the assurance that it would be fixed.

The defendant employer contended that there was no liability because of the doctrine of assumption of risk, which is still effective in Arkansas, as in many other states. Said the court:

The water glass had been encased or protected with a shield, from which one of the bars was broken or lost, leaving the glass exposed. The fireman, upon going to work upon this boiler immediately discovered the defective condition of the shield, and complained at the time to the engineer that it should be remedied and ought to be protected by a wire-screen shield. He was assured that it would be done that day and continued at work. He later complained again that it had not been done, and received the same assurance that it would be attended to shortly,

and on the night of the injury, upon first going to the boiler he discovered that it had not been repaired. He immediately complained to the engineer that it had not been, and said that if it were not fixed at 12 o'clock that night he would no longer continue to work upon the boiler. He was again assured that it would be attended to, and upon his returning to the boiler after 12 o'clock at night, when he believed, as he said, that it had been repaired, as he was promised that it should be, upon striking a match to see how the water was in the boiler, the explosion occurred, injuring his eye permanently, if his claim as to the injury be true, and the jury believed it was.

It is not disputed that the promise to repair was made by the engineer, whose duty it was to either make the repairs or have it done. . . . The fireman had the right to rely upon this promise to repair without assuming the risk for the time specified, and it was not denied that the promise was made, nor that the injury occurred upon his first use of the appliance after the time in which it was agreed to be repaired had expired, and before he could have known that the repairs had not been made and just as he had discovered that fact.

The time specified for the making of the repairs cannot be said to have expired so far as relieving him from the assumption of the risk of the danger is concerned under the circumstances of this case before he had an opportunity to know that the repairs had not been made, even though the hour fixed upon had passed.

In a New York case, decided in 1913, it was shown that the plaintiff was a fireman in a power house. He had charge of the boilers which were all equipped with water gages and when one of the glasses exploded it was his duty to replace it with a new one furnished him by the engineer.

On the day in question, a water gage exploded and the engineer gave him one which had been used before and directed him to clean it and place it on the boiler. The fireman called the engineer's attention to the fact that the gage was an old one, stained and dirty from use. The engineer replied that he knew it, but that it would do until new ones arrived and that it was the only one he had in stock. Accordingly, the fireman cleaned the gage and placed it upon the boiler. He had hardly finished his task when the gage exploded, showering bits of glass into his eyes, causing the injury complained of.

Expert testimony was introduced in which it was stated that it was exceedingly dangerous to use a water gage which had been used to the extent that it was stained and discolored from previous usage. That the sediment deposited on the sides greatly weakened the glass, which was further intensified by nonuse, and that the glass when used again heated unevenly due to the adhesive sediment in its inner portion, preventing uniform expansion.

The trial court dismissed the case at this point, but the appellate court reversed this judgment, saying that it was a matter for the jury to decide whether the accident was the result of the failure of the defendant employer to provide proper and safe water gages and in furnishing the plaintiff with an improper gage which was likely to explode when used under high-pressure steam.

A difference of opinion as to the best kind of a protection to use around a water gage oftentimes arises among skilled engineers. The Texas court held that the following instruction was the proper one for the court to give to a jury in such a case:

If you find from the evidence that at the time of the plaintiff's injury, there existed among skilled and competent railroad men, charged with the duty of protecting water glasses on engines, a difference of opinion as to the safest mode of protecting such glasses, consistent with their efficient use as such, and the defendant company in the exercise of its best judgment, selected the kind of protection which was upon the engine and around the glass at the time of the plaintiff's injury, then the defendant would not be liable to the plaintiff even though the jury may conclude from the evidence that the kind of protection selected and used by the defendant was not the kind best calculated to prevent injury to the employees of defendant in case of the bursting of the water glasses, provided it used ordinary care in making the selection.

This instruction is based upon the theory of law that where it is necessary for an exercise of judgment as to the safest and best way in which to do certain work the employer's judgment, provided it is in good faith and due care is exercised, shall govern, as against the judgment of the employee. But a difference of opinion exists even here, and other jurisdictions might challenge the Texas court although it does, in the main, express the true theory in such cases.

Where a water gage bursts without any apparent cause, with or without a guard, in the absence of statutory requirement or complaint from the injured workman, one court has said:

The servant agrees to use in the service the particular kind of implement or machine; and if, under such circumstances, harm comes to him it must be ranked among the risks he assumed when he entered the service.

In the cases considered the common-law theory of liability applies, both as to what liability attaches to the employer where the servant makes complaint as to the defective condition of a water gage and where he goes about his work without making a complaint prior to injury.

In other instances, however, this question might arise and be disposed of in a different manner. For instance, under the workman's compensation acts, assumption of risk as a defense to the employer is abolished, whether he accepts or rejects the acts. In case the employer accepts the workman's compensation acts, he is liable for the payment of compensation to an employee who is injured in the course of his employment, without reference to the manner in which the employee is injured.

In this connection it makes no difference whether the employee complained as to the defective condition of a water gage or its protecting screen or not. He may go about his work unmindful of any defect and without complaint and still recover when injured.

But suppose that the employer does not care to come under the protection of the workman's compensation acts, in those states where they have such legislation. He rejects the act, and then a workman is injured by the explosion of a water gage.

It makes no difference, under this statement of fact, whether the workman complained of the defect in advance or did not; if he is injured, the employer will find his hands tied, so far as using the defense of assumption of risk is concerned. He may escape liability on other grounds, but it is very problematical as to whether that can be done, for the compensation acts abolish, in most jurisdictions, all the common-law defenses.

A consideration of this question is one that is at all times interesting and profitable for employers to solve. Each employer should determine, at the earliest possible moment as to what his status is in regard to such cases, in order that he can govern his policy accordingly.

Misunderstanding oftentimes arises as to the effect of the compensation acts upon the safety-appliance acts. It should be remembered that the compensation acts in no wise relieve the employer of the statutory duty to guard all his machinery and to protect his employees with the best possible safety appliances for the given object.

Air Service Needs Men Skilled in Trades

The Hun is on the run. He must be kept running until exhausted. The Air Service is to play one of the great parts in this tremendous operation. You are needed immediately if you can qualify in any of the following trades: Motor mechanics, airplane mechanics, riggers—airplane, armorers, chauffeurs, clerks, cooks, motorcyclists, stockkeepers, cabinetmakers, metal workers, welders, vulcanizers, painters, propeller makers, magneto repairmen, blacksmiths, engine repairmen, tailors, carpenters, machinists, auto mechanics, truckmasters, instrument repairmen, coppersmiths, electricians, engine testers, draftsmen, photographers, cobblers, camera repairmen, auto-body builders, balloon riggers.

Bring your card with serial number and listen to the interesting information that Lieutenant Billker has awaiting you. He will see you at any time between 8:30 a.m. and 4:30 p.m. weekdays, at 104 Broad St., New York City, Room 902. A great opportunity for doing your share to win the war awaits you.

Commercial Value of Exhaust Steam*

BY FREDERICK C. RUCK

Operating cost data from a 250-hp. isolated plant show the importance of utilizing exhaust steam and the need of such economy when competing with the central station.

UTILIZATION of exhaust steam is not only practicing economy, but it also helps to conserve the nation's resources of coal. There was never in the history of the nation such an opportunity for the engineer to make a showing as at the present time. A saving in fuel of 10 per cent. today is equal in dollars and cents to that of 20 per cent. two years ago.

There is hardly a concern or establishment today where steam power is used that some exhaust steam is not required for heating or drying or to heat large quantities of hot water, such as in breweries, malt houses, knitting and dye works, milk-condensing plants, evaporators, and numerous other places. In these establishments there is no excuse for using live steam at low pressure when there is plenty of exhaust steam available.

TABLE I. EXHAUST STEAM UTILIZED AND ITS COMMERCIAL VALUE IN PLANT OF MILWAUKEE PUBLIC MUSEUM

Month	Per Cent of Exhaust Utilized	Kw.-hr. Generated	Total Weight Exhaust and Live Steam Lb.	Exhaust Steam Utilized Based on 30 lb. per kw.-hr.	Commercial Value of Exhaust Steam
Jan.	100	47,880	4,075,491	1,436,400	$668.88
Feb.	100	42,239	3,759,257	1,267,170	592.72
Mar.	95	47,316	3,728,384	1,248,500	584.32
Apr.	80	37,995	1,975,301	911,880	432.84
May	60	39,040	1,248,559	702,720	338.72
Oct.	65	46,395	1,886,398	904,702	429.61
Nov.	90	47,855	2,137,003	1,292,085	603.93
Dec.	100	48,950	3,772,839	1,468,500	683.32
Average	86.25				
Total		357,670	22,583,232	9,231,957	$4,354.34

The total cost of coal for the entire year of 1915 when war prices were not prevailing was $4,479.27.

To predetermine the value of exhaust steam for a given size of plant the most difficult problem is to know just what amount or percentage of that available can be utilized during the year. This depends principally upon climatic conditions and the nature of the product manufactured.

In Table I are given the records for the power plant in the public museum at Milwaukee, Wis. The various percentages of exhaust steam utilized for the eight months of the heating season are average figures covering the last four years. During the summer months the average electrical load is about 90 kw. for 15 hours per day. During the eight months of the heating season the average load is 125 kw. with a peak of 210 kw. The cubical contents of the building is 4,000,000 cu.ft., and for heating there is installed 12,000 sq ft. of direct radiation and 34,000 lin.ft. of 1-in. indirect blast coils. Reference to the table will show that a total of 9,231,957 lb. of exhaust steam was utilized during the heating season, and if purchased from a public-utility company at current rates this quantity of steam would have cost $4354.34. This sum is about the average cost of coal at pre-war prices for the entire plant generating an average of 450,000 kw.-hr. and heating a building of 4,000,000 cu.ft. content.

TABLE II. WISCONSIN UTILITY RATES IN EFFECT UP TO 1918

Demand Charges

$36 per year per kw. of demand for the first 10 kw.
30 per year per kw. of demand for the next 50 kw.
24 per year per kw. of demand for the next 140 kw.
18 per year per kw. of demand in excess of 200 kw.

Payable in equal monthly installments plus energy charge as follows:

Energy Charges

3.5c. per kw.-hr. for the first 1000 kw.-hr. used during the month
2.5c. per kw.-hr. for the next 3000 kw.-hr. used during the month
1.5c. per kw.-hr. for the next 6000 kw.-hr. used during the month
1.0c. per kw.-hr. for all energy used in any one month in excess of 10,000 kw.-hr.

To show that a properly managed isolated plant of moderate size can compete favorably with the central station, the following comparison may be enlightening. Take a 250-hp. isolated plant operating nine hours per day and 26 days per month, having an average load factor of 75 per cent., furnishing heat and power in an industrial establishment and compare the cost of production with the cost of similar service supplied by a public-utility company. In making the comparison pre-war prices were taken, the price of coal to the isolated plant being $3 per ton and the rate for central-station service being the Wisconsin utility rates in force up to 1918. Table II shows the rate including both the demand and energy charges. Table III gives the cost of central-station service according to Wisconsin utility rates. Two-thirds of one engineer's salary has been charged against the utility company to allow for a mechanic to look after repairs and upkeep of motors and other machinery which otherwise would be attended to by the engineer of the isolated plant. The cost per month is $842.60, or 2.56c. per kilowatt-hour.

TABLE III. COST OF POWER PER MONTH FROM A UTILITY COMPANY

Average power consumption = 250 x 0.75 = 187.5 hp.
Average consumption in kw. = 187.5 x 0.746 = 140 kw.
Average consumption per day of 9 hours = 140 x 9 = 1260 kw.-hr.
Average consumption per month of 26 days = 1260 x 26 = 32,760 kw.-hr.

Energy Charge	
First 10,000 kw.-hr. per month at 2c	$200.00
Remaining 22,760 kw.-hr. per month at 1c	227.60
Total energy charge	$427.60
Demand Charge	
First 10 kw.-hr. each at $3	$30.00
Second 50 kw.-hr. each at $2.50	125.00
Remaining 80 kw.-hr. each at $2	160.00
Combined energy and demand charge per month	$742.60
Average cost per kilowatt, cents	2.26
Two-thirds of one engineer's time at $150	$100.00
Total cost per month	$842.60
Net total cost per month per kw.-hr., 1c	2.56
Total yearly cost, central station service = 842.60 × 12 =	$10,111.20

TABLE IV. ISOLATED PLANT INSTALLATION AND INVESTMENT

Two 72-in. by 18-ft. tubular boilers and fittings with either Hawley furnaces or underfeed stokers	$4,000
One 200-kw. direct connected engine and generator	5,000
Switchboard and connections	1,000
Feed-water heater and high- and low-pressure piping	2,000
Feed pumps and pipe covering including heater	800
Total cost of installation	$12,800
Overhead Expense per Year	
Depreciation, 5 per cent. and interest on investment 5 per cent	$1,280
Insurance	400
Total	$1,680

As shown in Table IV the initial cost of such a plant based on pre-war prices would be $12,800, or $64 per kilowatt. With 5 per cent. depreciation and 5 per cent. interest on investment and a sum of $400 for insurance, the overhead expenses per year exclusive of any building charge would be $1680.

Table V gives the total cost to operate and maintain such a plant as $785.97 per month and $9431.64 per year.

TABLE V. COST PER MONTH TO OPERATE ISOLATED PLANT

Average power consumption per month, from Table III = 32,760 kw.-hr.
Coal consumption = 32,760 x 7 ÷ 2,000 = 114.66 tons per month.
Cost at $3. per ton = $343.98 per month.

Itemized Expense	
Coal	$343.98
Engineer's salary	150.00
Fireman's salary	100.00
Oil, packing, cotton waste and other supplies	15.00
Water, based on yearly average at 4.5c. per 100 cu. ft.	7.00
Carting ashes	15.00
Repairs	15.00
Insurance	33.33
Depreciation at 5 per cent. on $12,800	53.33
Interest at 5 per cent. on $12,800	53.33
Total cost per month	$785.97
Total cost per year = $785.97 x 12	$9,431.64

From Table III it will be seen that the average power consumption per month was 32,760 kw.-hr. Allowing 7 lb. of coal per kilowatt-hour at the switchboard, including all stand-by losses, the coal consumption is 114.66 tons per month, which at $3 per ton amounts to $343.98.

*Abstract of paper read before the National Association of Stationary Engineers at Cincinnati, Sept. 12.

Table VI gives the comparative cost of central-station and isolated-plant service when both furnish only electric power. The balance in favor of the isolated plant is but $56.63 per month, or $679.56 per year. This small margin only goes to show that were it not for the exhaust steam the isolated plant would have to be kept in excellent condition to break even with a central station.

TABLE VI. COMPARATIVE COSTS OF CENTRAL-STATION AND ISOLATED-PLANT SERVICE WHEN BOTH FURNISH ONLY ELECTRIC ENERGY

Monthly Costs	
Central station	$842.60
Isolated plant	785.97
Balance per month in favor of isolated plant	$56.63
Yearly Costs	
Central station	$10,111.20
Isolated plant	9,431.64
Balance per year in favor of isolated plant	$679.56

As to the value of exhaust steam, Table VII shows the Wisconsin utility rates for steam heating, which are based on a sliding scale of from 80c. to 50c. per 100 lb. for the first 150,000 lb. of steam used per month, and for all steam exceeding this amount, 45c. per 1000 pounds.

TABLE VII. WISCONSIN UTILITY STEAM-HEATING RATES IN EFFECT UP TO JANUARY, 1918

First 25,000-lb. condensed steam used in one month 80c. per 1000
Second 25,000-lb. condensed steam used in one month 70c. per 1000
Third 25,000-lb. condensed steam used in one month 60c. per 1000
Next 75,000-lb. condensed steam used in one month 50c. per 1000
All over the above amounts steam used in one month 45c. per 1000
Cost for the first 150,000-lb. used per month $90.

Table VIII gives the amount of exhaust steam available and its commercial value for the plant under discussion. The figures are based on 30 lb. of exhaust steam per kilowatt-hour at the switchboard, assuming an average of 86.25 per cent. available for heating. The rebate value of the exhaust steam for the eight months of the heating season is $3232.96, a handsome sum for so small a plant.

TABLE VIII. EXHAUST STEAM FROM 250-HP. PLANT OPERATING AT 75 PER CENT. LOAD FACTOR

Total kw. per month (from Table III)	32,760
Total exhaust steam at 30 lb. per kw.-hr.	982,800
Total at 86.25 per cent. utilization	848,065
Total per season of 8 months	6,784,480
Commercial Valuation	
Total amount above 150,000 lb. (848,065—150,000)	698,065
First 150,000 lb.	$90.00
Remaining 698,065 lb. at 45c. per 1000 lb.	314.12
Total value of exhaust steam per month	$404.12
Rebate value of exhaust steam for 8-months heating season	$3,232.96

Table IX shows the comparative test of central-station vs. isolated plant service where with the former the boilers of the isloated plant are used to furnish steam for the eight months of the heating season. This is a condition where it is not possible for the central station to extend its heating mains, but it will extend its power line for electric service. It is assumed that the exhaust steam of the engine is equal to two-thirds of the total amount required. For this reason only two-thirds of the fireman's salary is charged and two-thirds of the interest and depreciation on the boiler, also one-third of the engineer's salary, the other two-thirds being charged to the care and maintenance of motors and other machinery. Under these conditions the combined services of heat and power are $336.68 cheaper per year than if both were furnished direct from the central station, as is shown in Table X. Here the balance in favor of the isolated plant is $3912.52 per year.

TABLE IX. COMPARATIVE YEARLY COST OF CENTRAL-STATION POWER SERVICE WITH HEATING SUPPLIED BY BOILERS OF ISOLATED PLANT, AND ISOLATED POWER SERVICE WITH HEATING DONE BY EXHAUST STEAM

Central Station	
Total live steam required (From Table VIII), lb.	6,784,480
Appr. lb. steam to heating system per lb. coal, including all standby losses	6.5
Total coal required = 6,784,480 ÷ 6.5	1,043,754
Cost at $3 per ton	$1,563
Itemized Expense:	
Coal	$1,563.00
Two-thirds of one fireman's salary for 8 months	533.28
One-third of one engineer's salary for 8 months	400.00
Two-thirds of the interest and depreciation on boilers, piping and pipe covering	400.00
Total cost for heating	$2,896.28
Cost of central station power (from Table VI)	$10,111.20
Total cost per year for heat and power	$13,007.48
Isolated Plant	
Yearly operating cost for the same service as shown in Table VI	$9,431.64
Balance in favor of isolated plant	$3,575.84

TABLE X. COMPARATIVE COST OF CENTRAL-STATION AND ISOLATED-PLANT SERVICE, BOTH SUPPLYING ELECTRICAL ENERGY AND HEAT

Central Station	
Cost of electric service (From Table VI)	$10,111.20
Cost of live steam equal to exhaust from isolated plant	3,232.96
Total cost of heat and power service	$13,344.16
Isolated Plant	
Cost of heat and power service (From Table VI)	$9,431.64
Balance in favor of isolated plant	$3,912.52

After credit is given to the isolated plant for the rebate on the exhaust steam, the net cost per kilowatt-hour is 1.57c., as compared to 2.56c. for the central station. This is shown in Table XI. In Table XII the rebate value of the exhaust steam is shown to be $5577.12. If 100 per cent. of the exhaust steam were used throughout the entire year, the balance in favor of the isolated plant would be $6256.71. The cost of production under these conditions would then be 0.87c. per kw.-hr. The foregoing figures only go to prove the great value of exhaust steam to the isolated plant and the necessity for its maximum utilization.

TABLE XI. COST PER KW-HR. IN ISOLATED PLANT WHEN VALUE OF EXHAUST STEAM IS DEDUCTED

Total operating cost per year	$9,431.61
Commercial value of exhaust steam	3,232.96
Net cost of electric service	$6,198.65
Total kw.-hr. per month (From Table III)	32,760
Total kw.-hr. per year (32,760 x 12)	393,120
Net cost per kw.-hr. ($6,198.65 ÷ 393,120) = cents	1.57

In the discussion it was brought out that in competition with the central station it is not so much what an isolated plant can do as what it is doing. The method of charging a flat depreciation rate of 5 per cent. was questioned. A plant that is in good condition after 20 years of service has some value. On the other hand, certain equipment might become obsolete in a few years so that it would be a liability rather than an asset. The modern tendency is to make a yearly appraisal, taking into consideration the repairs that have been made and the real value of the plant for the service it is performing.

TABLE XII. COMPARATIVE COST OF CENTRAL-STATION AND ISOLATED-PLANT SERVICE, WHEN LATTER IS USING 100 PER CENT. OF EXHAUST STEAM

Central Station	
Total kw.-hr. generated per month (From Table III)	32,760
Pounds steam delivered to heating system per kw.-hr.	30
Amount of low-pressure steam required to equal 100 per cent of exhaust steam from isolated plant = 32,760 x 30 =	982,800
Cost of first 150,000 lb.	$90.00
Cost of remaining 832,800 lb. at 45c. per 1000	374.76
Cost of low-pressure steam per month	$464.76
Cost per year = $464.76 x 12 =	$5,577.12
Cost of electric power (From Table III)	$10,111.20
Total cost for combined service	$15,688.32
Isolated Plant	
Cost of combined service (From Table V)	$9,431.61
Balance in favor of isolated plant	$6,256.71
Production cost per kw.-hr. crediting rebate of exhaust = ($9,431.61—$5,557.12) ÷ 393,120 = cents	0.87

War Profits Tax and Excess Profits Tax

"By a war-profits tax we mean a tax upon profits in excess of those realized before the war.

"By an excess-profits tax we mean a tax upon profits in excess of a given return upon capital.

"The theory of a war-profits tax is to tax profits due to the war.

"The theory of an excess-profits tax is to tax profits over and above a given return on capital. The excess-profits tax falls less heavily on big business than on small business, because big business is generally overcapitalized and small businesses are often undercapitalized.

"The war-profits tax would tax all war profits at one high rate; the excess-profits tax does and for safety must tax all excess profits at lower and graduated rates"

Pennsylvania Boiler Rules Modified

The Industrial Board of the Department of Labor and Industry has issued a new ruling as a temporary war amendment to the code of safety for construction and operation of steam boilers in Pennsylvania. All plants that operate a steam boiler are affected. The ruling follows:

Until further notice in this emergency, steam boilers not Pennsylvania standard, may be installed and operated in this Commonwealth, provided the prospective purchaser or user makes a written request to the Department of Labor and Industry setting forth therein information concerning the construction and history of such boilers as becomes necessary to determine the safe working steam pressure and subject to the following rules:

In new construction of boilers not Pennsylvania standard, the factor of safety shall be not less than five. This factor of safety shall be increased 0.5 each five years thereafter.

For second-hand boilers the factor of safety shall be not less than 5½. This factor shall be increased 0.5 each five years thereafter.

When the chemical and physical properties of materials in the shell plate are not known, the tensile strength shall be assumed at not more than 50,000 for steel plates and 40,000 for iron plates. All such boilers shall be inspected and tested prior to operation by an inspector duly qualified by the Pennsylvania Department of Labor and Industry.

San Francisco Has Large Fuel Meeting

A joint meeting of the San Francisco Sections of American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers and American Chemical Society was held at the Engineers' Club in that city on Sept. 26 under the auspices of the Mechanical Engineers' Section. The subject of the evening was "Fuel Conservation." At this first meeting 325 persons were present.

The speakers and their subjects were: Albert E. Schwabacher, U. S. Fuel Administrator for California, "Fuel Conservation"; A. H. Markwart, Civil Engineer, "Production of Energy"; D. M. Folsom, U. S. Fuel Administration, Oil Division, "Future Requirements of Oil"; John A. Britton, Vice President and General Manager, Pacific Gas and Electric Co., "The Use of Gas as a Conservation Measure"; H. G. Butler, Power Administrator, "Electric Consolidations and Their Relation to Fuel Conservation"; P. M. Downing, Chief Engineer Electric Department, Pacific Gas and Electric Co., "Sources of Energy Supply"; Harry S. Markey, A. S. M. E., "District Steam Heating as Related to Fuel Conservation"; Major George F. Sever, "War Industries"; W. J. Davis, Pacific Coast Engineer, General Electric Co., "Railroad Electrification as a Fuel Conservation Measure"; Prof. Edmund O'Neill, American Chemical Society, "The Chemical Side of Fuel Conservation"; Capt. W. A. Brewer, Royal Engineers, "Fuel Saving in England."

Ambrose Swasey Gives $300,000 for Engineering Research

Ambrose Swasey, of Cleveland, Ohio, has just given Engineering Foundation an additional $100,000 for endowment of engineering research. In 1915 he gave $200,000 for this purpose, so that his gifts total $300,000. Mr. Swasey's original gift made possible the establishment of Engineering Foundation by United Engineering Society, representing the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers.

Mr. Swasey is a past president of the American Society of Mechanical Engineers and is well known as a designer and builder of large telescopes, other optical instruments and fine machine tools. His gifts have been inspired by his conviction as to the necessity for research in engineering sciences, in connection with the war and in keeping the United States in the forefront of the nations in industrial development in the new peace era. His latest gift is an expression of his appreciation of the war service which the United Engineering Society and the Engineering Foundation have rendered to the country. Generous as are these gifts, other endowment is much needed in order that the large work which Engineering Foundation has in hand may be put forward without delay, for the welfare of the country.

Mr. Swasey's additional gift was announced Monday, Oct. 7, at a joint meeting of the Trustees of United Engineering Society with the Engineering Foundation Board in Engineering Societies Building, 29 West 39th St., New York City.

Air Heating Table

F. Schumann's Manual of Heating and Ventilation.—*The Ideal Fitter*

Cubic feet of air one B.t.u. will raise one degree F. at different temperatures: Specific heat of air 0.2375. At zero one cubic foot of air weighs 0.0864 lb. and

$$\frac{1 \text{ lb.}}{0.0864} = 11.574 \text{ cu.ft.} \qquad \frac{11.574}{0.2375} = 48.77 \text{ cu.ft. raised one degree by 1 B.t.u.}$$

From this formula the following table is constructed, small fractional decimals being omitted.

Temp. Air. F. Deg.	Weight of 1 Cu.Ft.	Cu.Ft. in 1 Lb.	Cu.ft. 1 B.T.U. Will Raise 1 Deg. F.	Temp. Air F. Deg.	Weight of 1 Cu.Ft.	Cu.Ft. in 1 Lb.	Cu.ft. 1 B.T.U. Will Raise 1 Deg. F.
0	0.0864	11.58	48.77	112	0.0694	14.40	60.60
12	0.0842	11.87	50.00	122	0.0682	14.65	61.60
22	0.0824	12.14	51.00	132	0.0671	14.90	62.80
32	0.0807	12.40	52.20	142	0.0660	15.15	63.80
42	0.0791	12.64	53.10	152	0.0649	15.40	64.90
52	0.0776	12.88	54.10	162	0.0638	15.65	66.00
62	0.0761	13.13	55.20	172	0.0628	15.90	67.00
70	0.0750	13.34	56.30	182	0.0618	16.17	68.00
72	0.0747	13.39	56.40	192	0.0609	16.42	69.10
82	0.0733	13.64	57.40	202	0.0600	16.67	70.10
92	0.0720	13.90	58.60	212	0.0591	16.92	71.30
102	0.0707	14.14	59.20				

B. T. U. REQUIRED FOR HEATING AIR

This table specifies the quantity of heat in British thermal units required to raise one cubic foot of air through any given temperature interval.

External Temperature, Deg. F.	Temperature of Air in Room 40 Deg.	50 Deg.	60 Deg.	70 Deg.	80 Deg.	90 Deg.	100 Deg.	110 Deg.	120 Deg.	130 Deg.
—40	1.802	2.027	2.252	2.479	2.703	2.928	3.154	3.379	3.604	3.829
—30	1.540	1.760	1.980	2.200	2.420	2.640	2.860	3.080	3.300	3.520
—20	1.290	1.505	1.720	1.935	2.150	2.365	2.580	2.795	3.010	3.225
—10	1.051	1.262	1.473	1.684	1.892	2.102	2.311	2.522	2.732	2.943
0	0.822	1.028	1.234	1.439	1.645	1.851	2.056	2.262	2.467	2.673
10	0.604	0.805	1.007	1.208	1.409	1.611	1.812	2.013	2.215	2.416
20	0.393	0.590	0.787	0.984	1.181	1.378	1.575	1.771	1.968	2.165
30	0.192	0.385	0.578	0.770	0.963	1.155	1.345	1.540	1.733	1.925
40	0.000	0.188	0.376	0.564	0.752	0.940	1.128	1.316	1.504	1.692
50	0.000	0.000	0.184	0.367	0.551	0.735	0.918	1.102	1.286	1.470
60	0.000	0.000	0.000	0.179	0.359	0.538	0.718	0.897	1.077	1.256
70	0.000	0.000	0.000	0.000	0.175	0.350	0.525	0.700	0.875	1.049

Terminal Pressures per Stage in Air Compressors

The best practice adopted in the design of air compressors is as follows: The maximum terminal pressures are, for one stage, 80 to 100 lb. per sq.in.; two stages, 600 lb., three stages, 1500 lb., four stages, 2500 to 3000 lb., five stages, 4500 lb., and above 4500 and up to 6000 lb. per sq.in., which is about the highest pressure for which an air compressor has been constructed, six or seven stages. In the case of very small machines these pressures, for a given number of stages, are often exceeded in order to reduce complication, says J. M. Ford, in a paper read before the Greenock Association of Shipbuilders and Engineers, as reported in *The Engineer*, London. Machines have been constructed and work quite satisfactorily when compressing 2500 lb. per sq.in. in two stages. The temperatures attained, however, make it necessary to carry out the cylinder lubrication by soapy water.

German silver is manufactured in several ways. It is composed of nickel, copper and zinc in varying proportions. One method of manufacture is to melt all the copper to be used in the mixture, and two-thirds of the nickel and zinc, in a graphite crucible and then add the rest of the nickel and zinc. In another method the copper, nickel and zinc are melted all at one time, then more copper and zinc are added. Should the metal appear porous, a fireclay pipe containing pitch is pushed into the metal mixture to deoxidize it. A third way is to melt a copper-nickel alloy and then gradually add the preheated zinc. In a fourth method, monel metal is used as a base.—*Indian Engineer.*

New Publications

McGRAW CENTRAL STATION LIST. Published by the McGraw-Hill Co., Inc., New York. Cloth; 4½ x 8½ in.; 797 pages. Price, $15.

This is the 1918 edition of this book, which is published annually. It is practically an encyclopedia of the electric-lighting industry, containing, as it does, a list of almost 6000 companies, of which 375 are new. In the case of each company it gives the name and location, the owners or controlling interests, the capitalization, the bonded indebtedness, the names of the officers and their addresses, details as to the number and size of the electrical and steam units in the plant, the lighting load and its rates, the cost of fuel and the territory served. All this information is given in condensed form and is arranged according to states, the names of the towns and cities being in alphabetical order. It thus forms a complete inventory of the central-station equipment of the country, as well as of Canada, Mexico and the West Indies. It is of great interest and value to manufacturers of power-plant equipment and electrical appliances, holding companies, financial institutions and public-service commissions.

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA. By Halbert P. Gillette and Richard T. Dana. Published by McGraw-Hill Book Co., Inc., New York. Red morocco, flexible; 4½ x 7 in.; 1734 pages; 335 illustrations. Price, $6.

The chief objection raised against all compilations of cost data is that they become obsolete in a very short time, because of the changes in wage rates and prices of materials. It cannot be denied that these changes do occur and that the fluctuations may be very great, particularly in times like the present. For this reason, the authors of this book have taken great pains to point out that if cost data were to be revised at every change in wages or prices, it would be practically impossible to get out an up-to-date compilation. Accordingly, they have collected cost data and have given in each case the date and the location of the work, thus enabling the investigator to determine the wage rate and the prices existing at that time and place and so making it possible for him to make proper allowance for changes in these factors. It must be admitted that an estimate of probable cost is easier, with even incomplete data as a guide, than when no information whatever can be found regarding the work to be done. The authors have gathered and arranged a vast quantity of material relating to costs in connection with the following subjects: Buildings, chimneys, moving and installing, fuel and coal handling, steam power, internal-combustion engines and gas producers, hydro-electric plants, first cost and operating expenses of complete electric light and power plants, overhead and underground electrical transmission and distribution, lighting and wiring, belts, shafts and motor drives, compressed air, gas plants, pumps and pumping, conveyors, hoists, cranes and elevators, heating, cooking, ventilating, refrigerating and ice making, electric railways and a variety of other topics. These data are carefully selected and logically arranged and should be of value to the designer, the appraiser, the chief of construction, the superintendent of operation and the engineering student.

Obituary

William Allis, son of the late E. P. Allis, and successor to his father as president of the old E. P. Allis Co., died at Milwaukee on Oct. 10 at the age of 69 years. At the consolidation which resulted in the present Allis-Chalmers Manufacturing Co., Mr. Allis became chairman of the board of directors, retiring from active service.

Personals

B. H. Tripp has been appointed district manager of sales, Pacific Coast Territory, succeeding M. W. Priseler, of the Chicago Pneumatic Tool Co.

George E. Pfisterer has been appointed by the Green Fuel Economizer Co. district sales manager in charge of the Chicago Office at 1450 Old Colony Building.

J. A. Fritz, who has been chief engineer of the Scranton (Penn.) Electric Co.'s power plants, has resigned to accept a position as works engineer for the Penn-Seaboard Steel Corp., of Chester, Penn.

Robert T. Forbes, who has been in charge of the Chicago office of the Green Fuel Economizer Co. since the death of George H. Klumph, has been appointed special engineer, with headquarters at the general offices, 90 West St., New York.

A. G. La Pierre and F. O. Southbrook have been appointed traffic manager and manager order and production respectively, of the Chicago Pneumatic Tool Co., and will make their headquarters in the home office of the company, Fisher Building, Chicago.

C. E. Haygood, manager of the railway department of the Manila Electric Railroad and Light Co. of Manila, P. I., is visiting the United States on a vacation and for the purpose of consulting with the officers of the J. G. White Management Corp., New York, the operating managers of the Manila company. He expects to return to the Philippines sometime before the first of the year.

Miscellaneous News

A Boiler Exploded in the coal-mining district at Stillwater, Penn., on Oct. 4, scalding the fireman so badly that he died at the hospital a few hours later.

Gas Engine Injures Four—A serious explosion occurred in the Gray Chemical plant, Roulette, Potter County, Penn., badly injuring four workmen and destroying a section of a newly erected building and some new machinery. The blast occurred in one of the new buildings and was due to the explosion of a new gas engine, which was being tried out. The cause of the explosion is not known.

Fuel Oil and Coal Conservation Meeting at Chicago—In the interests of manufacturers who are users of fuel oil and coal in Illinois and Wisconsin, the United States Fuel Administration has arranged a meeting for manufacturing plant superintendents, engineers and others who are responsible for the proper utilization of these fuels, to be held at the La Salle Hotel, Chicago, at 9:30 a.m. on Oct. 24. The meeting will be largely educational, and will afford manufacturers an opportunity for checking up the condition of their plants, to see whether waste is occurring and what may be done to effect a saving. At least two representatives from each company to this meeting is requested. The tentative program is as follows: "The Oil Industry of the United States," by W. Champlain Robinson, Director Oil Conservation, Washington, D. C.; "U. S. Fuel Administration Coal-Conservation Program," by David Moffat Myers, Advisory Engineer, U. S. Fuel Administration; "Conservation of Coal in Power Plants," by Joseph W. Harrington, Administrative Engineer for Illinois; "Conservation of Fuel Oil for Industrial Purposes," by Nelson G. Phelps, District Engineer, Bureau of Oil Conservation; "Oil Storage and Measurements," by J. J. Connelly, mechanical engineer; "The Value of Fuel-Oil Accounting Systems," by J. C. Miller, consulting engineer, Chicago; "Principles of Fuel Oil Combustion Related to Industrial Furnaces," by Joseph W. Hays, Consulting engineer, Chicago; "What Represents an Ideal Industrial Fuel Oil System," by Max Sklovsky, mechanical engineer, of Deere Co., Moline, Ill.

Business Items

The Patterson-Kelley Co., manufacturers of feed-water heaters and hot-water heaters, announce the removal of their Philadelphia office to the Harrison Building, 15th and Market Sts., where their Frank F. Glenn, district sales manager, will be in charge.

Trade Catalogs

The Beaumont Manufacturing Company, Philadelphia, Penn., has issued Catalog 37, giving descriptions, illustrations and dimensions of its standard gates for controlling the flow of granular materials from bunker. The design of ashpits under boilers and the correct gate to use for this purpose are illustrated.

New Construction

PROPOSED WORK

Mass., Boston—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., will soon receive bids for installing mechanical equipment in boiler plant here; Specification No. 3533. Estimated cost, $200,000.

Conn., Shelton—Sidney Blumenthal Co. is receiving bids for the construction of a 1-story, 90 x 125 ft. power house addition. Estimated cost, $35,000. Gunwald Ares, 101 Park Ave., New York City, N. Y., Engr.

N. Y., Buffalo—G. Elias & Bro. has had plans prepared for the erection of boiler plant at 965 Elk St.

N. Y., Fairport—The Douglas Packing Co. plans to build a 36 x 50 ft. power house.

N. Y., Watertown—Armour & Co., 208 South La Salle St., Chicago, Ill., is receiving bids for the erection of a 3-story, 88 x 110 ft. refrigerating plant at 163 Academy Ave., and is in the market for refrigerating machinery. Estimated cost, $35,000. R. C. Clark, c/o owner, 120 Bway., New York City, N. Y., Engr.

N. Y., New York—The New York Catholic War Fund, 334 5th Ave., will install a steam heating system in the 3-story base hospital which it will erect on Tremont Ave. and Montgomery St. Total estimated cost, $250,000. Scott & Prescott, 1 Madison Ave., Arch.

N. Y., Brooklyn—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., will receive bids until Oct. 28 for installing electric wiring and lighting fixtures in nurses' quarters, here; Specification 3515.

N. Y., Brooklyn—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., will receive bids until Oct. 28 for installing heating and ventilating system in Ward Building "E" at Naval Hospital Reservation; Specification 3508. Estimated cost, $65,000.

N. Y., Brooklyn—The Morse Dry Dock & Repair Co., foot of 56th St., has had plans prepared for the construction of a 1-story, 35 x 65 ft. boiler plant.

Penn., Chambersburg—The Cumberland Valley R. R. plans to build an engine house. Estimated cost, $30,000. Crosby Tappen, Ch. Engr.

Penn., Noxen—The Armour Leather Co., 175 North Franklin St., Chicago, Ill., plans the erection of a 1-story boiler plant here. Estimated cost, $50,000. Westinghouse, Church, Kerr Co., 37 Wall St., New York City, N. Y., Engr., drawing plans.

Penn., Philadelphia—William Cramp & Sons Ship & Engine Building Co., Beach and Ball St., plans to build a 2-story, 305 x 400 ft. engine plant on Bridge and Edmond St. Estimated cost, $10,000.

Penn., Wilkes-Barre—The Vulcan Iron Works, Main St., plans to build a 1-story power plant.

D. C., Wash.—The Bureau of Supplies & Accounts, Navy Depart., will soon receive bids for furnishing under Schedule No. 6471½, 1 motor generator set.

D. C., Wash.—The Bureau of Supplies & Accounts, Navy Depart., will receive bids until Oct. 25 for furnishing under Schedule No. 6523½, 2 electric motors, delivery Annapolis, Md.

Va., Richmond—Ford, Bacon & Davis, Engr., is receiving bids for the construction of a 1-story, 180 x 600 ft. boiler shop at South Richmond for the Newport Shipbuilding Co., Newport News. Estimated cost, $250,000.

W. Va., Logan—The Guyan Machine Shop is in the market for low-voltage generators, power hammers, angle irons, cold rolled shafting and pumps, etc.

Miss., Greenville—The Black Bayou Drainage District, Greenville, will receive bids until Dec. 10 for furnishing and installing 2 drainage pumping units with combined capacity of 80,000 gallons per minute against low heads including supplementary machinery and appurtenances. Morgan Engineering Co., Goodwyn Institute Bldg., Memphis, Tenn., Engr.

La., New Orleans—The Machinery Exchange Co., Bienville and David St., is in the market for generator to use with magnet of 36 to 42 in.

Tenn., Knoxville—The John G. Duncan Co., 308 West Jackson Ave., is in the market for 2 return tubular boilers, 100 to 125 hp. steel casing with Dutch oven 100 to 125 hp.

Tenn., Memphis—The Mississippi River Commission, 1st and 2nd Dists., Custom House, will receive bids until Oct. 24 for furnishing boilers, turbines, pump set, feed water heater and electric light plant for a hydraulic grader No. 1820.

Ky., Louisville—The Gordon-Miller Coal & Coke Co. plans to erect a power plant; electrically driven machinery will be installed in same.

Ky., Willard—The Black Raven Coal Co. is in the market for electrical machinery. W. H. Morris, Gen. Mgr.

Ohio, Akron—The Department of Public Service will receive bids until Nov. 1 for furnishing one 45 hp. flusher, capacity of tank 1500 gals., nozzles front and side discharge, Ottofy patent, Akron made tires, hubometer attachment; pump to be run by separate engine to develop from 65 to 85 lb. pressure. Pump control to be within easy reach of driver's seat, thereby enabling the operator to stop the motor pump at will. H. S. Morse, Dir.

Mich., Detroit—The Anderson Forge & Machine Co., East Jefferson St., plans to build a 1-story, 65 x 100 ft. boiler plant.

Mich., Detroit—The Board of Water Commissioners will receive bids until Oct. 22 for furnishing and delivering f.o.b. cars at Detroit Water Works pumping station, 1 horizontal motor driven centrifugal pumping unit, to have a capacity of 70,000 gals. per minute, 1 having a capacity of 45,000 gals. per minute; also auxiliary equipment. H. S. Starkey, Secy.

Wis., Union Grove—The Electropure Dairy Co., Burlington, plans to construct and equip an electrically operated milk condensing plant here. Estimated cost, $35,000.

Iowa, Maquoketa—The city voted $65,000 bonds for constructing and furnishing a Maquoketa light and power plant. D. T. Bauman, City Clk.

Kan., Buffalo—The city will soon award the contract for the erection of a municipal light plant; plans include the installation of two 40 hp. generators, two 30 k.v.a. generators with exciters, switchboards, pole line material, and the erection of a brick power house. W. B. Rollins, 209 Railway Exchange, Kansas City, Mo., Engr. Noted Oct. 1.

Neb., Palmer—The city has awarded the contract for the construction of an electric-lighting and water works plant, to the Kelly Well Co., Grand Island. Estimated cost, $40,000. Noted Aug. 20.

Mo., Galena—The city plans improvements to its water works, including the erection of a pumping station. Estimated cost, $100,000. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., Engr.

Mo., Independence—The Independence Airless Co. is in the market for an 80 lb. upright steam boiler, 12 hp. engine, high and low pressure pumps and 10 to 20 hp. electric motors, for the manufacture of airless inner tubes for automobile tires. E. C. Harrington, Secy.

Mo., Kansas City—The American Butter Co., 540 Walnut St., is in the market for 25-ton ice machine, 60-hp. boiler, motor, etc. J. S. Carpenter, Pres.

Mo., Kennett—The Gideon-Anderson Lumber Co., plans to build a 12-ton ice plant and an electric light plant here.

Mo., St. Louis—The Dielectric Manufacturing Co., 224 South Vandeventer Ave., is in the market for electric motors and rubber compounding machinery. J. J. Kessler, Pres.

Mo., St. Louis—Washington University, Skinner and Lindell St., will install motors, lathes, general equipment for motor mechanics instruction shop in the 1-story, 32 x 220 ft. machine shop which it will erect. A. S. Langsdorf, Dean.

Tex., Eastland—The Eastland Light & Power Co., recently incorporated, plans to install machinery in the local electric power plant recently acquired; plans include the construction of electric transmission lines. G. W. Bishop, Ch. Engr.

Tex., Granbury—R. A. Grundy plans to rebuild the light, power, ice and water plant recently destroyed by fire, with a loss of $20,000.

Okla., Miami—The Fort Worth Lead & Zinc. Co. plans to install electric power at its North Century mill.

Okla., Miami—The Miami Ice Co. plans to erect an addition to its plant.

Okla., Ponco City—The city is having plans prepared for improvements to the electric-light plant and water-works system. Plans include the installation of a new generator, new main extension, etc. Estimated cost, $75,000. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., Engr. Noted Aug. 13.

Utah, Murray—The Progress Co. plans to construct a large electric light plant here, to serve this city and other nearby towns. George P. Cahoon, Pres.

Wash., Seattle—The J. F. Duthie Shipbuilding Co., 3262—11th Ave., have had plans prepared for the erection of a 1-story, 93 x 209 ft. punch and boiler shop. Noted Oct. 8.

Cal., San Francisco—Major G. F. Sever has recommended to War Industries Board, Wash., D. C., that $15,000,000 be spent on hydro-electric development in northern and central California. Plans include the construction of an additional power plant on Feather River by the Great Western Power Co.; one on the Stanislaus River by the Sierra & San Francisco Power Co. and construction of the Sheeps Rocks project on Pit River.

Cal., Wilmington—The Union Oil Co., Union Oil Bldg., Los Angeles, plans to erect a 1-story, 60 x 70 ft. boiler plant here.

Que., Sorel—J. E. Gill, Engr., is in the market for a pump, having a capacity of 1,500,000 gals., also one having a 3,500,000 gal. capacity, gasoline meter, etc.

Ont., Chatsworth—J. B. Bowes is in the market for a 8 to 15 hp. self regulating steam air compressor.

Ont., Toronto—The Turnbull Elevator Manufacturing Co., 126 John St., plans to build an addition to its boiler house. Estimated cost, $6000.

Ont., Welland—The Utility Electric Manufacturing Co. is in the market for an electric spot welder.

CONTRACTS AWARDED

Conn., New London—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., has awarded the contract for the construction of 2 subcharging stations, to James Niles & Son Co., 393 Main St., Worcester, Mass. Estimated cost, $16,837, (60 days).

N. Y., Randalls Island—Commission of Charities, Municipal Bldg., New York City, received bids for furnishing labor and material required for constructing and installing new steam and return lines from new boiler house and certain existing new buildings' in Childrens Home on Randalls Island, from Schute, Thornton & Bailey, 2 East 13th St., $143,000; Raesler Heating Co., 169 Amsterdam Ave., $215,000; Tarran, Mohoney & Munro, Grand Central Terminal, $218,000.

N. J., Cape May—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., has awarded the contract for the erection of a power house at the section base here, to Cramp & Co., Denckle Bldg., Philadelphia, Penn. Estimated cost, $37,321, (60 days).

Penn., Lewiston—The Susquehanna Silk Co., c/o George Kempleman, will build a 1-story, 50 x 100 ft. power house.

D. C., Wash.—The War Department has awarded the contract for the erection of an electric power plant and laundry at Camp Meigs near here, to Frank L. Wagner, 1413 H St.

S. C., Charleston—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., received only bid for constructing tanks, pumping plant and water system, from the Carroll Electric Co., 714—12th St., Wash., D. C., $42,000, (90 days).

Fla., Pensacola—The Bureau of Yards & Docks, Navy Depart., Wash., D. C., has awarded the contract for the erection of a heating plant here, to C. A. Born, 25 West Garden St. Estimated cost, $10,250.

Ohio, Dayton—The National Cash Register Co., Main and K St., will build a 1-story, 40 x 230 ft. addition to its power house. Estimated cost, $25,000. W. D. Patterson, Pres.

Mich., Detroit—The Welded Steel Barrel Corp., Hart and Charlevoix St., has awarded the contract for erection of a 1-story, 28 x 37 ft. boiler house, to De Lisle & Cooper, 38 Campu Bldg., $5000; contract for installation of heating plant equipment let to R. Peckham, 900 Hudson Ave.

Wis., Barron—The city will build a 1-story, 20 x 30 ft. power plant. Estimated cost, $20,000. J. C. Jacobson, 1135 National Soo Line Bldg., Minneapolis, Minn., Engr.

Iowa, Iowa Falls—The Iowa Falls Electric Co. will build a gas plant. Estimated cost $6000. H. F. Kellogg, manager.

Kans., Ellis—The city has awarded the contract for improvements to its electric-light plant, to Anton Jacobs, Hays. Plans include the erection of a power house addition and installation of generator. Black & Veatch, 507 Interstate Bldg., Kansas City, Mo., Engr. Noted July 2.

S. D. Huron—The Farmers Co-operative Packing Co. has awarded the contract for the erection of a 1- and 2-story, 60 x 80 ft. power house in connection with the 4-story packing plant which it will build, to Eugene Schuller, Hotel Vendome, Minneapolis, Minn.

Okla., Okmulgee—The city let contract for furnishing and installing boilers, pumps, engine, and generator in water-works, Secs. Nos. 3, 4, 5 and 7, to Merkle Machinery Co., 508 Interstate Bldg., Kansas City, Mo., $68,200.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck.	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b., Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line Current	Line One Yr. Ago	Tide Current	Tide One Yr. Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70	$3.25—3.40
Mine-run	2.35—2.50	3.00—3.15
Screenings	2.05—2.20	2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10, other rates p. 95.